III. *On the Julianiaceæ: A New Natural Order of Plants.*

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[Plates 18-24.]

Contents.

I. History.

It is surprising that a genus of plants so striking in aspect, so distinct in the shape of its fruit, and so widely spread as *Juliania* is in Mexico, should have entirely escaped observation by all the earlier European travellers in that country. Francisco Hernandez, Physician to Philip II of Spain, was the first European to investigate the Flora of Mexico, where he spent six years (1571–1577), chiefly in the State of Mexico. He laboured most assiduously, especially in medical botany, but his elaborate descriptive and illustrative works on the subject, which were not published until after his death, contain no mention of a plant or product bearing the vernacular name generally applied to *Juliania*. Nor does this name appear in any of the posthumous botanical works of Cervantes, or in those of Mociño and Sessé, and it has not been found in the writings of any of the minor writers on Mexican botany of the seventeenth and eighteenth centuries.

C. J. W. Schiede, M.D., who accompanied Ferdinand Deppe on a botanical expedition to Mexico in 1828, was apparently the first to send dried specimens to Europe of one of the species of *Juliania*. Sets of their joint collections exist in

the Herbaria of Kew, the British Museum, Berlin, Vienna, Halle, and probably in those of some other institutions; but it seems highly probable that the specimens of *Juliania* were collected by SCHIEDE on some subsequent excursion, because the narrative of his journeys with DEPPE does not cover any part of the country in which the genus is known to be represented.

SCHIEDE settled and practised medicine in the city of Mexico, where he died of typhus in 1836, and there is no definite record of any excursions he may have made after he parted from DEPPE. In the meantime, however, he had sent further collections of dried plants to his friend Dr. D. F. L. VON SCHLECHTENDAL, but it was not until 1843 that the latter published an account of the genus of plants in question.

Under the name of *Hypopterygium adstringens*, he very fully described the material he had an opportunity of examining, but he had neither female flowers nor mature seeds, and he was doubtful whether the fruit was the result of one or more flowers.

His description is very accurate, and in the following extract he expresses his views of the affinities of the plant, which he regards as the type of a new Natural Order.

"Crescendi modo habituque dum florent mascula saltem specimina arboris a Mexicanis Coachalalate v. Guauchalalate nominatæ *Elaphria* tantopere æmulantur ut ipsi plantæ viventis collectores sub *Elaphrii* nomine specimina servare inducerentur. Fœminei vero flores et fructus, illico te impedient a tali conjunctione. Cujusnam vero familiæ socia erit singularis hæc arbor? *Sapindaceis* eam adnumerare fructus species externa suaderet, *Terebinthaceis* stigmatum et pistilli conformatio, quæ *Pistaciarum* in mentem revocat, *Cupuliferis* involucrum, et sic porro, sed nullam scimus quacum omnibus notis conveniret. Meliorum vero exemplarium (nostra sunt humiditate corrupta et mucore cariosa) et plantæ viventis observatio plura docebit: seminum maturorum fabricam, ovulorum situm et fœminei floris statum juvenilem. Novi ordinis, multis aliis affinis, sed ab omnibus bene recedentis typum in hac stirpe vidimus, quam in Hernandesii opere frustra quæsivimus. Nomen a beato amico in litteris datum mutavimus ne falsum eo characterem indicare videamur. Descriptione plantæ masculæ hispanice conscripta et altera amicissimi SCHIEDE nec flores fœmineos nec fructum tangente usi sumus."

It is impossible to tell from the foregoing extract, or from the rest of SCHLECHTENDAL'S article, how far he was indebted to SCHIEDE for the details of his description, and it has not been ascertained what Spanish description of the male plant to which he alludes he had before him. None has been found.

Shortly after the publication of his generic name, *Hypopterygium*, SCHLECHTENDAL became aware that it had already been used to designate a genus of mosses. In consequence, he substituted for it the name *Juliania*, and in this connection he adds: "Epitheton *adstringens* a beato amico [SCHIEDE] in schedula datum verosimiliter

vim adstringentem hujus arboris indicat. Amici nomen genericum *Amphipterygium*, quum ala basalis tantum nec cingens adsit, rejecimus."

Previous to this, LA LLAVE had published a *Juliania caryophillata*, but the same plant had already been described by KUNTH under the name of *Choisya ternata*. *Juliania* was therefore unoccupied, and SCHLECHTENDAL was fully justified, according to the views of the majority of botanists, in taking it up. *Juliania* is certainly preferable on account of its simplicity, and after due consideration I have decided to retain it, though at one time I was in favour of taking up *Amphipterygium*. Dr. ROSE and some other, mostly American, botanists, who act on the principle of once a synonym always a synonym, would adopt the latter name, and we have jointly published diagnoses of the species under both generic appellations.

SCHLECHTENDAL'S objection that it was inappropriate is not justifiable, because the axis of the fruit is winged on both sides, but, apart from priority, there is a more potent objection to using it, inasmuch as it cannot be found on SCHIEDE'S labels.

In our publication of the diagnoses of the species it is stated that all inquiries as to whether specimens of *Juliania*, collected by SCHIEDE, existed in certain Continental herbaria were fruitless. Since then Dr. R. PILGER, of the Berlin Herbarium, has made a further search and succeeded in finding three sheets of fragmentary specimens, all of which he believes were collected by SCHIEDE, though, through some mistake in the handwritings, two of them have been attributed to C. A. EHRENBERG, who collected plants in Mexico about a decade later than SCHIEDE. Dr. A. ENGLER, the Director of the Berlin Botanic Gardens, kindly lent one of the sheets, and furnished exact copies of the labels of the other two, so that I was enabled to verify my earlier determination from SCHLECHTENDAL'S description of the original species. But no trace exists of SCHIEDE'S alleged name, *Amphipterygium*. There are various renderings of the vernacular name, and on one of the labels is the name *Amphipterocuspis adstringens*, in the handwriting, according to Dr. PILGER, of SCHIEDE. This further complication does not favour the revival of SCHIEDE'S alleged name, even if it could be proved that he used it in his correspondence.

In order to exhaust all possible sources of specimens of *Juliania*, application was made to Mr. JULES POISSON, of the Paris Herbarium, who, after much searching, found a fragile specimen, in fruit, of the original species, collected by Captain THIEBAUT, of the French Navy, at Manzanillo, a new locality, in 1866.

Since SCHLECHTENDAL'S time, until I took up the study of the genus five years ago, nobody seems to have had sufficient material to supplement his description. WALPERS condenses the original description, and places the genus in the Burseraceæ without any explanation. LINDLEY placed it among the genera *Incertæ sedis*. In 1854, A. GRAY described, also from very incomplete material, what he considered a second species of the same genus, collected in Peru. An examination of fuller, though by no means complete material, has led me to separate it generically under the name of *Orthopterygium*. BENTHAM and HOOKER, and also BAILLON,

placed *Juliania* doubtingly in the Anacardiaceæ; whilst ENGLER excluded it from that natural order with the following remarks:—"Est planta valde singularis, cujus fructus minime ut BENTHAM indicat unilocularis sed quinque locularis, loculis angustissimis. Quamvis canales resiniferi adsint, attamen non tales, quales in Anacardiaceis observantur. Plantæ locus systematicus, cum flores nondum cogniti sint, mihi plane dubius remanet."

Finally, HARMS, in dealing with insufficiently known genera, limits himself to the following remark:—"Eine durchaus ungenügend bekannte Gattung, da noch zu entscheiden ist, ob das, was hier als weibliche Blüthe aufgefasst ist, eine Blüthe oder ein Blüthenstand ist."

Whether the imperfect fruit hitherto examined was the result of one or more flowers; whether it was a simple or multiple fruit, was still an unsolved problem.

It is true that SCHLECHTENDAL, in the extract given above, speaks of an involucre; and in his detailed description he says: "Fœmineis de floribus dubia nos movent. Ovarium enim utrum adsit unicum variabili stylorum et stigmatum numero coronatum, an duo connata sæpius adsint eodem involucro inclusa quæri potest."

At the time when I was engaged on the Botany of Central America there was no specimen of *Juliania* either at Kew or in the British Museum, and I had no knowledge of it beyond the name.

In September, 1900, the late Mr. MARC MICHELI presented Kew with a small set of E. LANGLASSÉ'S Mexican plants. Among them was a specimen of a plant in fruit, which, after much research, was identified with SCHLECHTENDAL'S *Juliania adstringens*; but the most careful and tedious examination carried me no further than SCHLECHTENDAL had reached 60 years before. Previous to this (in 1899), as I afterwards found out, Kew received a specimen of a plant collected in the Mexican State of Jalisco by Mr. C. G. PRINGLE, n. 6871, and named *Juliania adstringens*, SCHL. This specimen bears young foliage and male flowers, and, on carefully comparing it with SCHLECHTENDAL'S description and LANGLASSÉ'S specimen in fruit, I came to the conclusion that it represented a different species of the same genus. I brought this under the notice of Sir WILLIAM THISTELTON-DYER, and he agreed that in order to get further material and complete our knowledge of the genus, it was desirable to publish figures and descriptions of what Kew possessed. Accordingly the male specimen was published as *Juliania mollis*, HEMSL., and the fruiting specimen as *J. adstringens*, SCHL.

This publication had the desired effect, for it brought me a letter at the end of 1901 from Dr. J. N. ROSE, Curator in the "Division of Plants" of the United States National Museum at Washington, from which I make the following extract:—"I have only recently returned from my third journey into Mexico, and have brought back a large quantity of plants, some of which you will certainly be interested in. You will also be interested in what I have to tell you about *Juliania*. For more than six years I have been at work off and on, at this genus, but for the lack of material

I have never published anything upon it, but each time have brought specimens, and this year was especially fortunate in collecting, near the type-locality, both male and female plants. In looking up the subject since my return, I find that you have anticipated me and have published two very beautiful plates and some interesting notes. I think you are perfectly right in making PRINGLE'S 6871 a new species, though I had provisionally and doubtingly referred it to *J. adstringens*, SCHL. There are, however, more than two species in Mexico. I have certainly four well-marked species, and possibly six. With regard to the position of this genus, I think it must be regarded as the type of a new order. I do not think it has any relationship to either Burseraceæ or Anacardiaceæ. My conclusions in the field were, that it must be closely related to Juglandaceæ, a relationship which you also suggest."

In this communication, Dr. ROSE gave a description of the floral structure, as he understood it, in the field. He also most generously offered to send all his specimens and notes to me, leaving it to my judgment in what form publication should be effected. I gladly accepted, and through the kindness of the Trustees of the Bentham Fund, Miss M. SMITH made an elaborate series of drawings under my direction. As there were still some structural points on which we were not quite clear, and Dr. ROSE contemplated another visit to Mexico, it was decided to publish a description of the genus, as then understood, and brief diagnoses of the species.

Subsequently, Dr. ROSE sent me a quantity of young female flowers in formalin, and then the previous result of much patient investigation was easily verified and established beyond dispute. There was no longer any doubt about the fruit being a compound one.

After his return, in November, 1903, from his fourth journey to Mexico, Dr. ROSE sent me a further supply of specimens, supplemented by photographs and notes, which are utilised in the following pages.

Young fruit was received again during the summer of 1905, but intermediate stages between the ovule and the mature seed are still wanting.

It has already been stated that no mention of a bush or a tree that could be identified with *Juliania* has been found in HERNANDEZ or any of the other old authors, and the earliest mention found of the vernacular name, which is variously spelt, is in an "Ensayo para la Materia Médica Mexicana," compiled in the year 1832 and published 1889. In this work are given the vernacular and botanical names of vegetable drugs, but under "Cuauchalala" it is stated that the genus had not been identified: "Aun no se ha podido reconocer su género." Apparently only the bark is used, and this was procured from Matamoros (Puebla) and its neighbourhood. In the 'Farmacopea Mexicana' of 1896 the same vernacular name appears and the variant, Cuauchalalate, and it is doubtfully referred to *Rajania subsamarata*, MOC. et SESSÉ (Dioscoreaceæ), a name not found elsewhere. RAMIREZ,

a more recent writer, gives both spellings of the name, and doubtfully refers it to *Dioscorea*. Dr. ROSE, writing of *J. adstringens* at Yautepec, in the State of Morelos, says:—"The tree is well known to the Mexicans, who call it 'Cuauchalalate' and use it as a medicine. The bark is boiled and applied as a wash to external sores." SCHIEDE was the only person, so far as we know, who wrote the name Guauchalalate.

It is noteworthy that *J. glauca* bears the same vernacular name in the State of Jalisco.

Orthopterygium was originally discovered by ANDREW MATHEWS in 1831, and specimens collected by him exist at Kew and Paris. The specimen at Paris is, in some respects, better than the one at Kew, and through the kindness of Professor E. BUREAU it was lent to me for examination. This enabled me to ascertain that the shape and attachment of the ovule are quite different from what obtains in *Juliania*.

About the same period JOHN MACLEAN, a merchant at Lima, sent specimens to the late Sir WILLIAM HOOKER, bearing male flowers, probably from the same locality, and possibly also collected by MATHEWS, as he was at one time in the employment of MACLEAN. The label accompanying the specimens bears the following note:—"Huaucui of the natives. Male flowers of diœcious shrub seldom seen with leaves, and always black as if burnt or blasted." MATHEWS describes it as a small tree. It is a singular fact that the types of both genera were first collected about 75 years ago.

I should, perhaps, mention here that enlarged drawings, illustrative of the structure of the flowers and fruits of the two genera, were exhibited at the Royal Society's Conversazione on May 13, 1904, under the names of *Amphipterygium* and *Orthopterygium* (Programme, p. 12). These names, as well as the term *Amphipterygiaceæ* for the natural order, were taken up in various reports and records, but I now, for reasons given above, think it better to return to *Juliania*, and to call the order Julianiaceæ.

Juliania was founded in honour of JULIAN CERVANTES, a priest and son of the botanist, VICENTE CERVANTES. *Orthopterygium* is derived from ὄρθος, straight, and πτερυγιον, a little wing, given in allusion to the straight, equal-sided, winged fruit, in contrast to the more or less oblique, unequal-sided fruit of *Juliania*.

II. GENERAL DESCRIPTION.

1. *Juliania*.

Juliania is exclusively Mexican, and all of the species are tortuously-branched, diœcious shrubs or small trees, usually of straggling and unsymmetrical growth, and the leaves are deciduous. Exact dimensions of *J. adstringens*, as it grows near Yautepec, Morelos, were taken by Dr. ROSE, and the largest individual seen

was about 7·5 m. high with a trunk just 75 cm. in circumference, about 1·2 m. above the base. An idea of its aspect is afforded by the accompanying figures, from photographs taken by Dr. ROSE. But this species is usually shrubby and only 2·5–3 m. high.

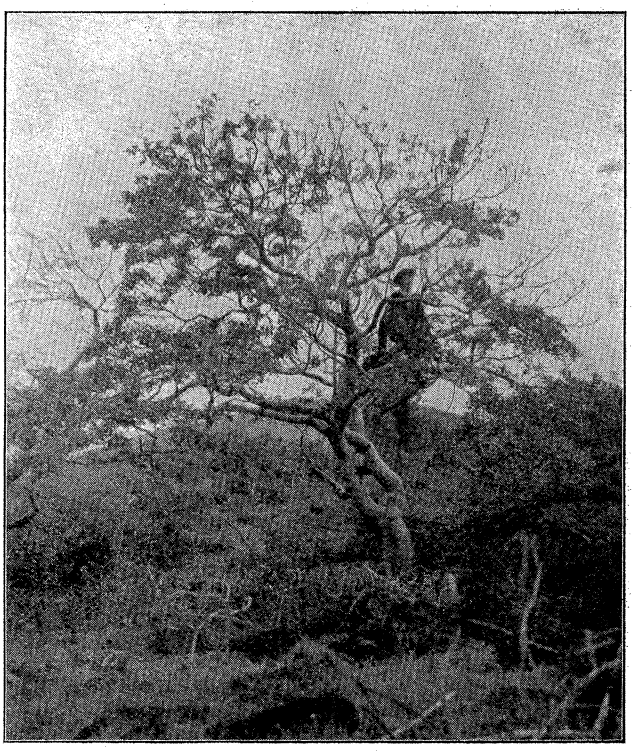


FIG. 1.—*Juliania adstringens.* The largest tree seen in fruit.

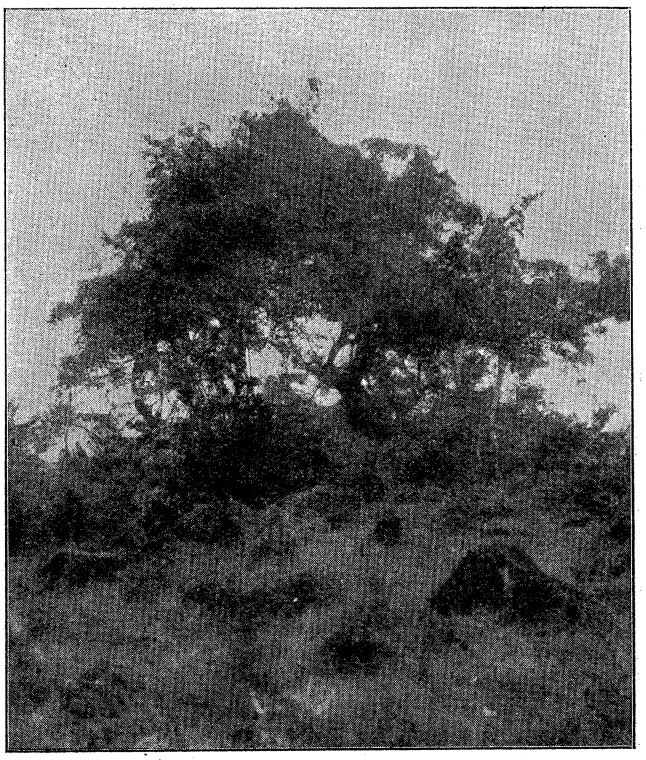


FIG. 2.—*J. adstringens.* A male tree in flower, over-run with vines.

The trunk of the smaller individuals is smooth, brown or reddish, with here and there excrescences of bark, which in very old trees extend in long bands 2–3 cm. thick. This is the old dead bark, which LANGLASSÉ describes as being like that of the cork oak.

The living bark, when cut, exudes a milky, sticky juice, and in thicker parts is full of little nuggets of consolidated resin. The ultimate branches are very brittle and of two kinds, barren and fertile, or leafy shoots and flowering shoots.

The latter elongate very little from year to year, and bear a dense cluster of leaves and flowers or leaves and fruits, intermixed. Often, if not always, the leaves fall before the fruit, and sometimes the fruit persists until new leaves are produced. The annual elongation of barren shoots is much greater, but rarely as much as 30 cm., and their leaves are scattered along their whole length.

The leaves are alternate and unequally pinnately compound; the number of leaflets varying in the different species from 3–11. Often the number of leaflets to a leaf varies from three to seven on the same branch, and frequently some of the leaves of the

barren branches are reduced to a single leaflet; that is in *J. adstringens*. When pricked, the leaves exude a milky juice, which quickly forms a drop and falls.

The male flowers are borne in more or less branched catkins, and in size, colour,

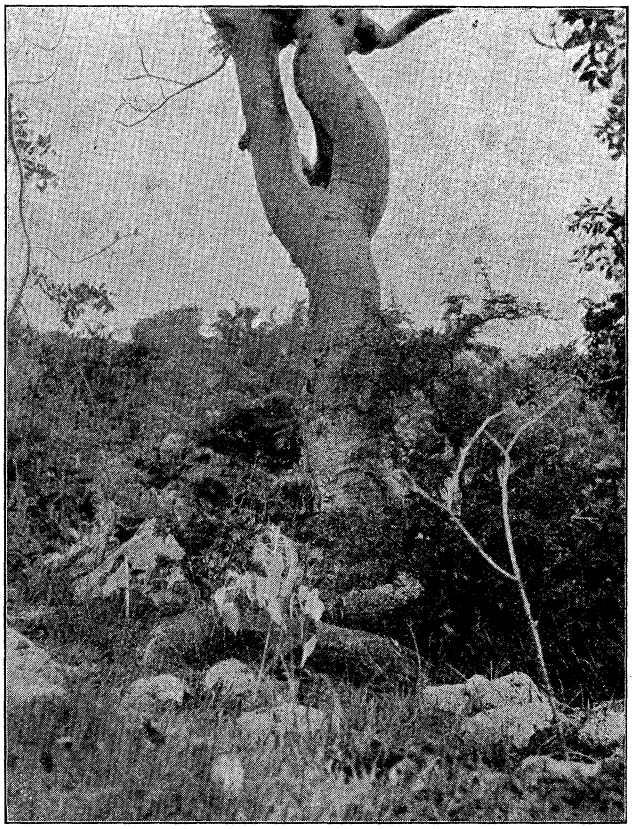


FIG. 3.—Trunk of fig. 1, 75 cm. in girth at about 1·2 m. from the ground.

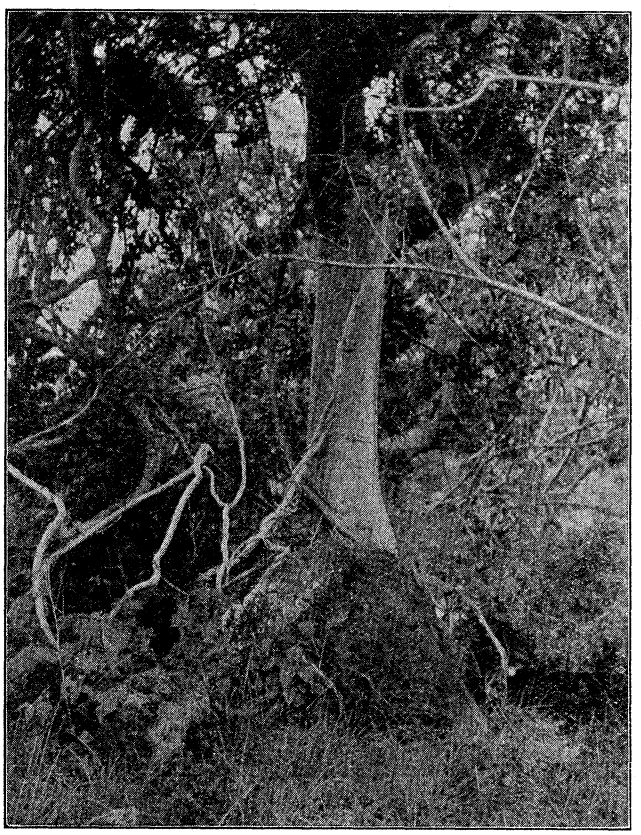


FIG. 4.—Trunk of fig. 2, showing the stems of *Cissus*, *Hippocratea*, and *Pachyrhizus*, climbers, which over-run the top.

and structure are very much like those of many species of oak. The female flowers or inflorescences are very small and inconspicuous, and easily overlooked when quite young. But the mature fruit is a relatively conspicuous object, especially as it is clustered, sometimes as many as 35–40 together, as shown in Plate 19. It is dry and pendulous, usually 3–5 cm. long, the upper part being in the form of a depressed sphere, supported by a flattened, unequal-sided, wing-like stalk. They are usually borne in pairs on a common stalk, sometimes singly, sometimes in threes.

Juliania amplifolia is very different from *J. adstringens*, both in habit and in the size of the leaves, reminding one of the genus *Rhus*. Generally it is a taller, more slender tree; and the leaves are usually composed of 7–11 lanceolate, pointed leaflets, instead of three to five. Fig. 5 shows trees bearing young leaves and a few old fruits.

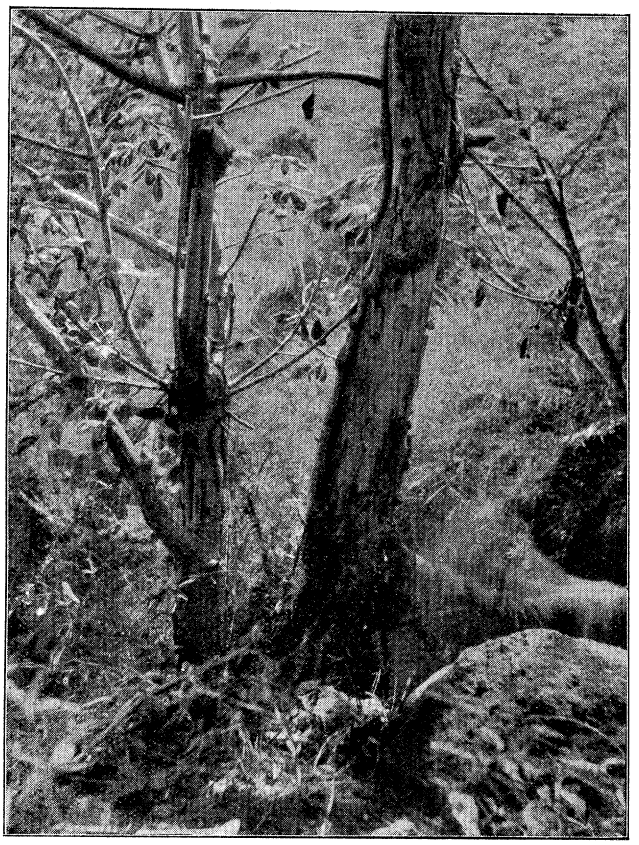


FIG. 5.—Lower part of Trees of *Juliania amplifolia*.

2. *Orthopterygium*.

This is a dicœcious shrub or small tree, native of Peru, still very imperfectly known. It has imparipinnate leaves, usually composed of seven leaflets, about 2·5 cm. long and strongly resembling those of the rosaceous *Polylepis racemosa*, Ruiz and Pavon.

As in *Juliania*, the leaves and flowers are clustered at the tips of otherwise naked branches. Nearly all the specimens seen consist of a tuft of leaves 7–10 cm. across, at the very tips of smooth, slender branches 25–35 cm. long. Interspersed with the leaves are panicles of male flowers, at the most 25 cm. long. The individual flowers are smaller than those of *Juliania*, being only about 3 mm. across, and the somewhat rudimentary perianth is shorter than the stamens. The fruit, of which there are only detached specimens at Kew, is narrow, equal-sided, straight, and 6–7·5 cm. long. A. GRAY describes his material as consisting of "two leafless branches with nothing besides a terminal fascicle of immature, pendent, samaroid fruits, the largest 6·5 cm. long and 1·2 cm. wide."

III. Geographical Distribution.

1. *Juliania.*

So far as at present known, *Juliania* is confined to Mexico, and the various species occur in isolated localities between about 17° 40′ and 23° N. lat. and 97° and 105° W. long., and at altitudes of about 1500 to 5500 feet. Schiede's original locality for *J. adstringens* is: San Francisco Tetecala, near Mecatlan, at Tlaquiltenango. Tetecala is in the State of Morelos, and some distance below Yautepec, where Dr. Rose collected the same species. He gives the following particulars of its occurrence there: "*Juliania adstringens* is found along that branch of the Mexican Interoceanic railway running from the City of Mexico to Puente de Ixtla. I have travelled over the whole line, but have never seen this tree except in one place, some three miles below Yautepec, in the State of Morelos. The exact station is 163½ kilometres from the City of Mexico. It appears to be restricted to a rather narrow belt and is nowhere very common. The site is an old lava field now overgrown with grass and scattered shrubs and vines. In this vegetation there is only one arborescent species of any size, and that is an *Ipomœa* (*I. arborescens*, Don ?), which has a trunk 2 feet or more through. Among the small trees and shrubs noted were a second *Ipomœa*, *Crescentia alata*, *Acacia farnesiana*, *A. ambigua*, various shrubby species of *Opuntia*, a tall *Cereus*, *Bursera aptera*, *B. jorullensis*, *Hœmatoxylon boreale*, *Pithecolobium dulce*, a species of *Ceiba*, a *Celtis*, and at least two species of *Mimosa*. Among the herbs was a *Houstonia*, a *Cassia*, a *Commelina*, *Agave collina*, and an *Ipomœa*. The individuals of *Juliania* are rarely grouped, but scattered singly in the general vegetation. Some of the larger trees are over-run with vines, such as *Cissus*, *Hippocratea*, and *Pachyrhizus*. On some trees were found two or three species of *Tillandsia*." In another communication, Dr. Rose states that in the little town of Yautepec, trees are growing in the hedges, enclosing the small hamlets of the poor, and the trunks show that they have been frequently called upon to furnish bark for some remedy.

There are numerous specimens in herbaria collected by other travellers in the same locality, which Mr. C. G. Pringle places at 4000 feet. It has also been found on lava beds at Cuernavaca in the same State; near Cuicatlan and Dominguilla, in the State of Oaxaca; in the valley of Las Balsas, Michoacan or Guerrero, and at Manzanillo, State of Colima. Apparently *J. adstringens* is at the present time the commonest species of the genus and the most widely spread.

Juliania mollis is only known from one locality in the Barranca de Guadalajara, North Jalisco, at an elevation of 4000 feet. It was discovered by Mr. C. G. Pringle, but nobody else who has visited the Barranca has succeeded in finding it, and only the male has been collected. The question has arisen whether it is specifically distinct from *J. adstringens*. Dr. Rose and I are of opinion that it is; but further material is necessary to determine the point. Dr. Rose is of opinion that it may

possibly be a variety of *J. amplifolia* which is reported from three, apparently different, localities in North Jalisco, namely, Barranca de Guadalajara; road between Bolaños and Guadalajara, and near Tequila. Data are insufficient to give an approximation of the size of the area over which this species is spread in this region. Mr. PRINGLE was the discoverer, and Dr. ROSE and his assistants have since twice visited the district and collected specimens. Dr. ROSE reports: "*Juliania amplifolia* is scattered along a barranca near Guadalajara, Jalisco, ranging from 3500 to 4300 feet altitude. This barranca is one of the largest of the lateral barrancas which run down to the great barranca, through which the Rio Grande de Santiago flows. Among trees and shrubs with which *J. amplifolia* is associated are *Ficus Pringlei*, *Heliocarpus reticulata*, and one or two species of *Bursera*."

"In this same barranca was collected the type of *Juliania mollis*, and although Mr. PRINGLE, who collected the original specimens, took me to the group of trees from which he thought his specimens were obtained, I failed to find anything answering to it."

J. amplifolia was also found by Dr. ROSE in the extreme south of the State of Durango.*

Finally, *J. glauca*, the fourth species of the genus, and a very distinct one, is only represented in herbaria by imperfect specimens in fruit from Jilotlan, in the extreme south of the State of Jalisco. LUMHOLTZ, the collector, places Jilotlan in the neighbouring State of Michoacan, and he gives cuachalalate as the vernacular name of this species.

The accompanying sketch map (p. 180) is intended to show the number and approximate positions of all the known stations for *Juliania*.

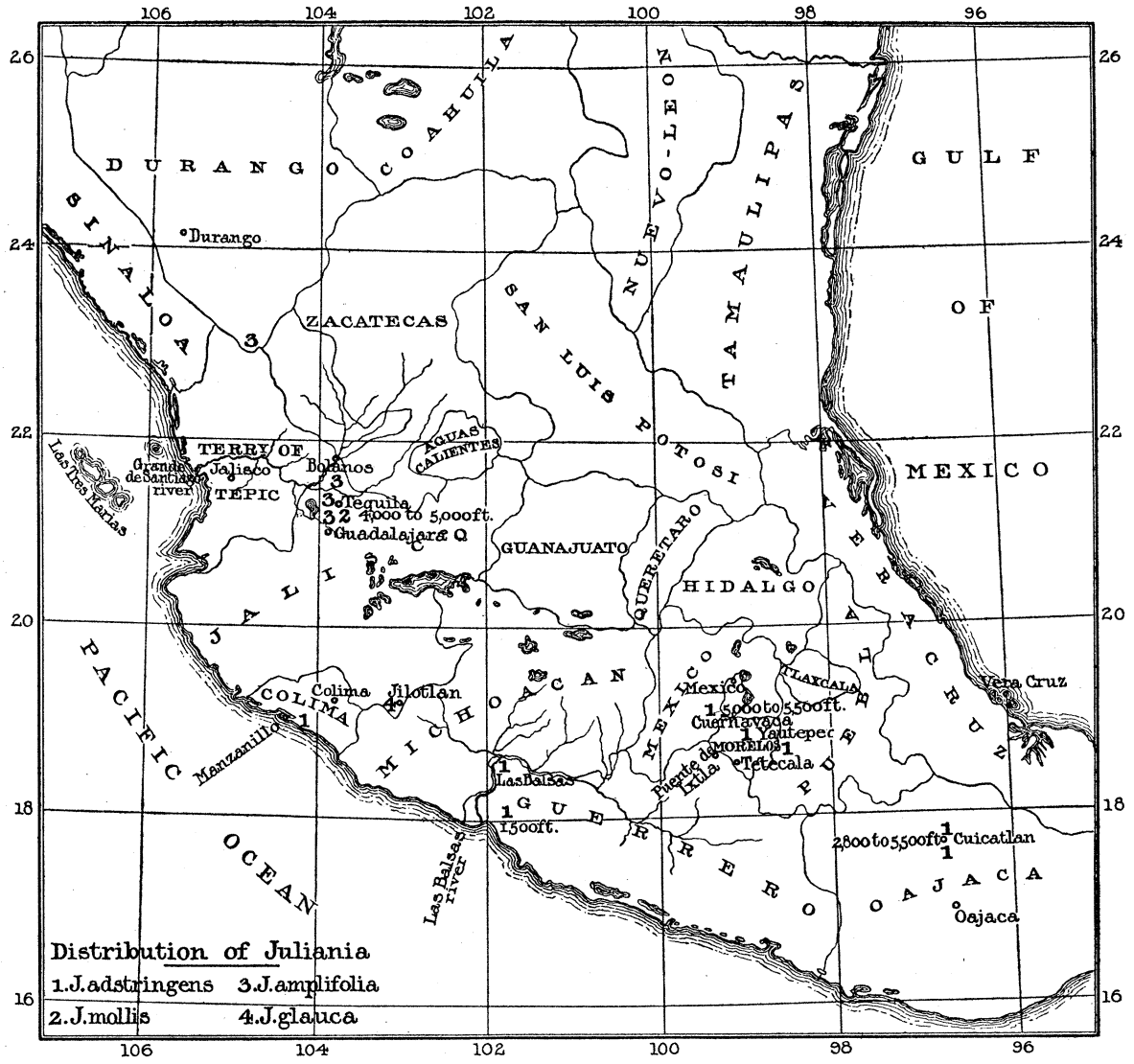
2. *Orthopterygium*.

The habitat of the Peruvian *Orthopterygium Huaucui* is about 2000 miles distant from the nearest locality of any species of *Juliania*. The exact position of the only place in which it has been found cannot be given, but it is in the Province of Canta, in the Department of Lima, between 11° and 12° S. lat. MATHEW'S label runs: "Small tree, covering the sides of the base of the Cuesta of Purruchuca, Province of Canta, Peru, April, 1831." MACLEAN gives no locality on his label, but it is presumably the same. Lima, in the handwriting of Sir WILLIAM HOOKER, appears on the sheet, but that refers rather to the department than the city. The specimen collected by the botanists of the United States Exploring Expedition is from the "vicinity of Yanga, Peru," which A. GRAY states is in the same district as

* Various fungi and lichens occur on the leaves and bark, including a new *Phyllosticta—P. amphipterygii*, RICKER.

"Maculæ subcirculares, pallidæ fuscæ, 2–8 mm. diam., sæpe confluentes, Margine prominulente fusco-rubro; perithecia sparsa, atra, epiphylla, 55–80 μ diam.; sporæ oblongæ, utrinque acutæ, subinde inæquilaterales hyalinæ, biguttulatæ 2·5–3 × 8–10 μ. In foliis *Amphipterygii amplifolii*, HEMSL. et ROSE."

Purruchuca. Although apparently plentiful where MATHEWS collected it, *Orthopterygium* must be rare, or very local, for we have not found any other record of it, and Dr. A. ENGLER who has monographed the Burseraceæ and Anacardiaceæ, orders in which imperfect specimens might have been placed, has not found any specimen in the numerous herbaria he has consulted.



IV. EXTERNAL MORPHOLOGY.

The Seed.

The seed of *Orthopterygium* is unknown. Of *Juliania* the seeds of three out of the four species are known. They are circular or oblong, compressed bodies, 6–10 mm. long, with a smooth, thin testa, and the embryo fills the whole cavity. Embryo horizontal; radicle elongated, ascending, and applied to the edges of the

thin, plano-convex, more or less oblique, sometimes obscurely lobed, cotyledons, which are epigæous in germination.

The Leaves.

The habit and aspect of the members of the Julianiaceæ are briefly described under another heading, p. 174, and it has already been pointed out that the deciduous leaves are imparipinnate and composed of from 3 to 11 leaflets. Frequently, too, some of the leaves on the barren branches, and probably the first leaves of the seedlings, are simple or reduced to one leaflet. There are four fairly distinct types of foliage in the order, counterparts of which exist in the Anacardiaceæ, and especially in the genus *Rhus*. Very similar leaves are also characteristic of the Juglandaceæ.

The leaflets of *Juliania adstringens* range from 3 to 7, and are very variable in shape, but they are mostly broadest above the middle, often almost truncate, coarsely and irregularly toothed and densely hairy when young. The leaflets of *J. mollis* are not very different, but they are broadest in or below the middle, and densely tomentose on both surfaces.

In *J. amplifolia* the leaves are usually composed of 7 to 11 leaflets, of almost uniform shape in all the specimens under observation. They are lanceolate, broadest near the base, tapering gradually upwards into a very acute tip, and regularly serrate nearly throughout their whole length. At first they are clothed with soft hairs, becoming glabrous with age, on the upper surface, at least. The leaves are very similar to small leaves of *Rhus typhina*.

J. glauca has glabrous or soon glabrescent leaves, glaucous on the under surface. The fully developed leaves of all the species of *Juliania* are at least 15 cm. long, and those of *J. amplifolia* sometimes as much as 30 cm. long, whilst those of *Orthopterygium* are of a smaller type, and only 5–7·5 cm. long. They are almost invariably composed of seven leaflets, about 2·5 cm. long.

Male Inflorescence.

The male and female flowers are borne by different trees, which are otherwise indistinguishable. The male inflorescence is a more or less densely branched panicle, from 2·5 cm. to 15 cm. long, with hairy, weak, thread-like branches and pedicels; the ultimate branches and pedicels irregularly clustered on the secondary branches of the larger inflorescences of *Juliania*. They are pendulous from the axils of the densely clustered leaves at the tips of the branches.

Male Flowers.

The male flowers are very numerous, small, green or yellow-green, consisting of a single, regular, very thin, hairy perianth, divided nearly to the base into four to nine narrow, equal segments, and as many stamens alternating with them. Individual flowers are only 3–5 mm. in diameter. The anthers are two-celled, basifixed, about

as long as the filaments, and they dehisce by longitudinal slits. Pollen grains very small, globose. Rudimentary pistil none. The male inflorescence and flowers, therefore, present no peculiar features or characteristics.

Female Inflorescence.

In the female inflorescence and flowers, on the other hand, there are structural peculiarities on which the order and genera are founded. The female inflorescences at the flowering stage are very inconspicuous objects and easily overlooked. They are of the same colour as the crowded hairy petioles of the simultaneously developing leaves, in the axils of which they are closely seated and almost hidden. Taken singly they are soft, hairy bodies, including the exserted styles, about 1·8–2 cm. long, flattened upwards through three-quarters or more of their length, then constricted, with a globose expansion above. The flattened part is the pedicel, and the globose expansion is the involucre in which the flowers are seated. It is surmounted by, usually, five very small lobes or teeth, which give it the appearance of an ordinary calyx, and it contains three (*Orthopterygium*) or four (*Juliania*) collateral flowers. The two lateral are apparently always imperfect; but only unripe fruits are known of the former. In *Juliania* the relatively large trifid styles of the two central flowers are usually fully developed and exserted from the narrow mouth of the involucre. Sometimes only one is perfect and exserted, and then the whole body might easily be mistaken for a flower.

Female Flowers.

The female flowers are destitute of perianth, consisting, therefore, of pistil only, and they are free from each other, but attached by their outer edges to the walls of the involucre. Each contains a solitary ovule. The ovary and style are hairy all over, except the stigmatic surface.

The Ovule.

The ovule of *Juliania* is a very remarkable one, and without a parallel, probably, in the whole vegetable kingdom. By ovule is here meant the entire structure occupying the cell of the ovary, although the part in which the embryo originates is small in relation to the whole body. As explained below, the rest of the body is regarded as an appendiculate funicle, but the funicle is, in the opinion, I believe, of most botanists, as much a part of the ovule as the caudicle is a part of the pollinium, though an ovule is complete, of course, without any obviously differentiated funicle. In the early flowering stage, but after the styles have grown out from the involucre, the ovule of *Juliania* is a thin, flat body, about 2 mm. in its greater diameter. It is attached to the base of the cell of the ovary, which, however, is sometimes oblique, as shown in Plate 19, fig. 3. It is somewhat variable in shape and structure, even in the same species, and in the

same stage; but the ordinary condition, when fully grown, so far as my investigations go, is a bilateral, cordate body, more or less unsymmetrical in outline, with two unequal, incurved lobes, whose tips are opposite and contiguous to each other, as in fig. 9. But it is possible that these are unfertilised ovules, though they have attained the length and diameter of a ripe seed, and it is also probable that figs. 6 and 7 represent normal conditions of the ovule at different stages. However, this is only a supposition, suggested by the fact that the condition represented by fig. 9 occurs in almost fully developed infrutescences of two different species. Opposed to this is the fact that the embryo is not differentiated until late in the development of the infrutescence.

Now, whatever the shape of the ovular body be, the two opposed, more or less equally developed lobes are present, and a vascular strand runs from the attachment of the ovule, at the base of the cell up and into one of these lobes; and in this lobe the embryo is formed. The question arises, what is the nature and function of the rest of the body? The answer that suggests itself, judging from what takes place in the development of the seed, is that it is a funicle with an appendage—a *funiculus appendiculatus*. The alternative is a placenta; but a placenta does not disappear during the development of the seeds; it usually increases in volume, as in the Myrsinaceæ, where the seeds are embedded in a fleshy placenta. Nearly the whole

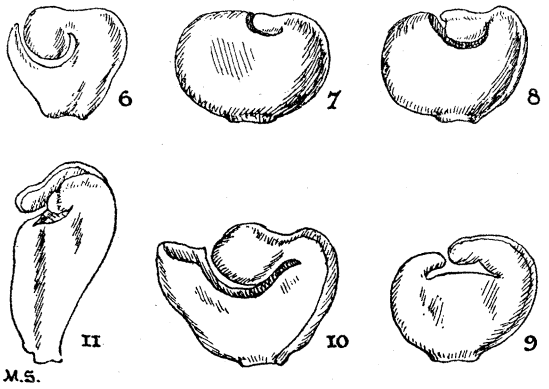


Fig. 6.—An Enlarged Ovule of *Juliania adstringens* in the early-flowering stage, but after the exsertion of the styles from the involucre. Natural size of ovule at this stage, about 2 mm. in its greatest diameter. Female inflorescence, at this stage, including the exserted styles and the flattened pedicel, about 2 cm. long; involucral part about 4 mm. in diameter.

Fig. 7.—An Enlarged Ovule of the same Species from a nearly full-grown infrutescence, 4 cm. long; involucral part at this stage about 8 mm. in its greatest diameter. Ovule about 6 mm.

Fig. 8.—The same Ovule, the embryoniferous lobe withdrawn from the socket or overlapping lobe.

Fig. 9.—An Enlarged Ovule of *J. amplifolia*, from a young infrutescence, about 6 cm. long; involucral part about 12 mm. in its greatest diameter. Natural size of ovule at this stage about 8 mm. in its greatest diameter.

Fig. 10.—An Enlarged Ovule of the same Species, showing the bilamellate appendage of the funicle in which the embryonal part was enfolded.

Fig. 11.—Another Ovule of the same Species, in which the slightly unequally bilateral body is folded longitudinally. Natural size of ovule at this stage about 5 mm. long.

of the ovule of *Juliania*, except the lobe in which the embryo is formed, breaks up and is absorbed during the growth of the seed, and the funicle is reduced to a narrow, flattened strand, more or less free from the body of the seed.

With regard to the variation observed in the ovular bodies of *Juliania*, some of them are very curious and perhaps abnormal; others are merely different stages of development, as shown in the plates illustrating this paper. As mentioned above, we believe that fig. 6 is the normal shape of the ovule in a very young condition—at least of *J. adstringens*, the only species of which we have seen young female flowers. Figs. 7 and 8 represent a stage in which the two opposite lobes are as nozzle and socket to each other, the nozzle being the embryoniferous lobe.

As already stated, we have not found any other ovule resembling that of *Juliania*; but in many of the Anacardiaceæ there is a considerable development of the funicle, though it is always unilateral. For example, *Euroschinus verrucosus* is figured by ENGLER as having a long, thick funicle, with an elbow-like expansion on the dorsal part near the base. Had the expansion been on the ventral part, there would have been a remote resemblance to *Juliania*. In some of the Araceæ, too, the funicle is very large in proportion to the embryonal part of the ovule; this is conspicuously exemplified in *Brachyspatha variabilis*, SCHOTT. Here an external resemblance is indisputable, but there the analogy ends, the funicular growth being unilateral and permanent. (See figs. 12 and 13.)

The Fruit of Juliania.

The fruits are known of three species of this genus, and they are very similar in appearance, though sufficiently different to be distinguishable from each other.

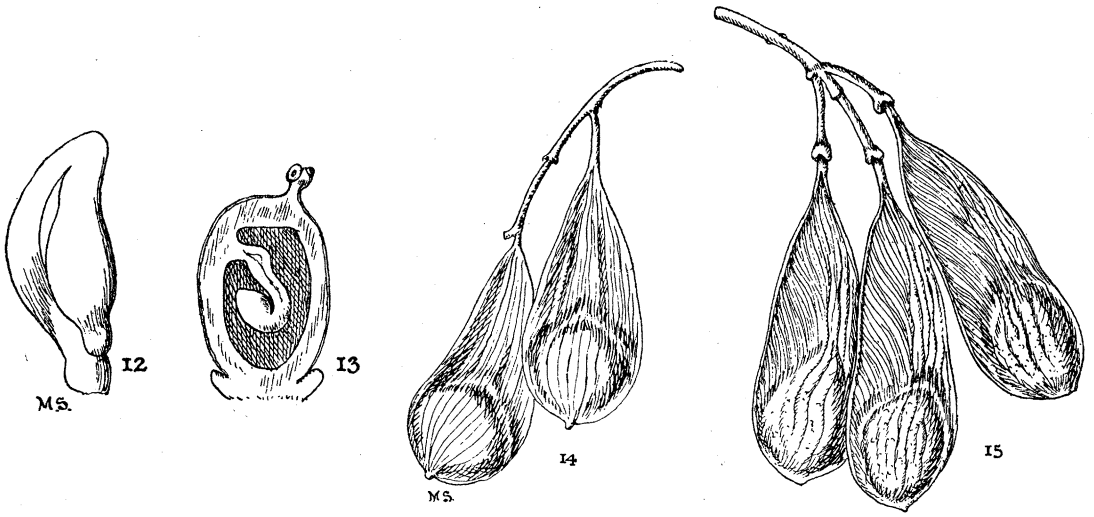


FIG. 12.—An enlarged Ovule of *Brachyspatha variabilis*, showing the highly developed funicle. After SCHOTT.

FIG. 13.—An enlarged Longitudinal Section of an Ovary of *Euroschinus verrucosus*, showing the ovule, enlarged. After ENGLER.

FIG. 14.—Fruit of *Juliania glauca*—natural size.

FIG. 15.—Fruit of *Platypodium elegans*, to show the very close external resemblance to *Juliania*.

Samaroid in form, they strongly resemble the samaroid pods of certain genera of Leguminosæ, especially those of *Platypodium* and *Myroxylon*, both tropical American genera of trees having pinnate leaves. At a short distance the resemblance must be delusive. But none of these inhabit exactly the same district. The ripe, exceedingly hard nuts of *Juliania* are only freed by decay of the tissues of the involucre, and germination takes place by the protrusion of the radicle through the apex from which the style has disappeared, and the ultimate withdrawal of the cotyledons and their appearance above ground.

The Fruit of Orthopterygium.

Ripe fruit unknown, but, including the flattened pedicel, it is evidently narrow, equal sided, and nearly the same width throughout (see Plate 24).

V. Microscopic Structure of the Ovule of *Juliania adstringens*.

(By L. A. Boodle, F.L.S.)

The structure of the ovule was examined chiefly by means of sections, but entire ovules were also viewed as transparent objects, after clearing in oil of cloves. A number of young inflorescences were embedded in paraffin and cut by the microtome, so that the ovule was seen in position; in other cases the ovule was removed from the ovary and cut by hand. The youngest ovaries were from dried material, and were used for microtome sections, after soaking out in boiling water. The expansion of the tissues, however, was found to be incomplete, the preparations being less satisfactory than in the later stages, shown by material which had been preserved in a weak solution of formalin.

The form and general structure of the ovule at the fertilisation-stage are as follows:—The ovule is flattened, and its shape varies considerably, but is often

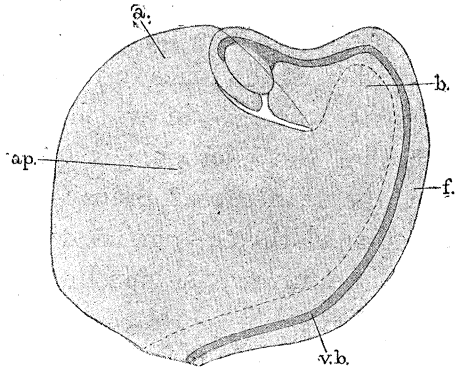


Fig. 16.

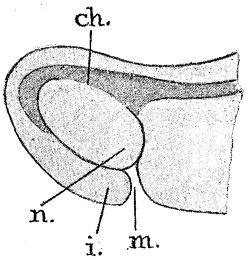


Fig. 17.

Fig. 16.—Ovule at the Fertilisation-stage, cleared in oil of cloves and seen in median optical section. *v.b.*, vascular bundle; *f.*, funicle; *ap.*, appendage of funicle. For explanation of *a* and *b*, see text. × 23.

Fig. 17.—Part of same Specimen, enlarged. *ch.*, chalaza; *n.*, nucellus; *i.*, integument; *m.*, micropyle. × 46.

between orbicular and reniform. The dimensions may be given roughly as 2 mm. for the greatest diameter, and $\frac{1}{3}$ mm. for the thickness. The nucellus and integument form a very small part of the ovule, and lie at the opposite side from the attachment to the placenta (fig. 16), *i.e.*, in the region of the sinus when the ovule is reniform. The vascular bundle (fig. 16, *v.b.*), after passing from the placenta into the ovule, runs near one margin, following the outline of the ovule until it reaches the chalaza (fig. 17, *ch.*), where it expands and branches, as will be described below. The long axis of the nucellus (fig. 17, *n.*) is usually oblique, but it may be nearly vertical or nearly horizontal. The chalaza occupies the greater part of the length of the nucellus on the upper side (figs. 17 and 19) when seen in a median section of the ovule, but in the other direction it is narrower, especially towards the free end of the ovule; consequently, in an oblique section one may see the nucellus attached by a small base in that region. The micropyle (fig. 17, *m.*) is directed downwards. From the relative positions of the chalaza, the micropyle and the vascular bundle, the ovule should be described as hemianatropous. As stated above, the axis of the nucellus varies in direction, but the relative positions of the chalaza and micropyle remain the same; hence the ovule is never truly anatropous. There is a single integument (fig. 17, *i.*). On one side of the micropyle in the median plane it is not free (on the right in fig. 16), and its limits are consequently indefinite.

The greater part of the ovule at this stage must be regarded as having been formed by enlargement of the funicle, and the portion of the ovule lying on the left in fig. 16, and bounded by the dotted line, may be described as the appendage of the funicle. It consists of a mass of parenchymatous tissue with no vascular bundles. The rough arbitrary limit between the funicle proper (fig. 16, *f.*) and its appendage (*ap.*), given by the dotted line, was chosen in its upper part on account of the arrangement of the superficial cells of the ovule. They form parallel curved rows, running from the region at *b* to the upper part of the appendage at *a*, and this seems to indicate that marked local growth had taken place in this region and direction. In the upper part of the appendage is a furrow, in which the nucellar portion of the ovule is partially embedded, so that the micropyle is quite hidden when the ovule is examined externally. In the transparent preparation of the ovule (fig. 16) the line running across the nucellus is the edge of the upper flap of tissue belonging to the appendage and lying over the furrow, the nucellus being seen through this tissue.

In a vertical section cut at right angles to the median plane and passing through the micropyle, the vascular bundle (fig. 18, *v.b.*) is seen to have broadened into the form of a crescent, so as to sheathe the chalaza. This expansion of the bundle is followed acropetally by branching into a number of bundles, which supply the integument. One or two branches are also given off by the vascular bundle before it reaches the chalaza. They pass directly down into the neighbourhood of the

micropyle, where the tissue is presumably integumental. Portions of these bundles (shaded) are seen in fig. 19 on the right, and in fig. 18 at *a*. The section shown in fig. 19 is median, and, therefore, similar to the optical section in fig. 17 ; the main vascular bundle is seen running along the chalaza and curving round for a short distance into the integument.

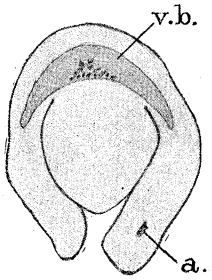


FIG. 18.

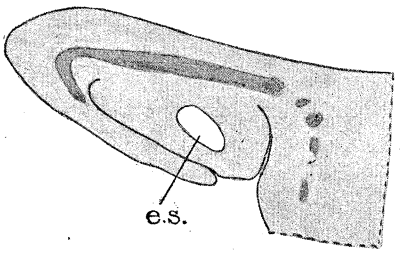


FIG. 19.

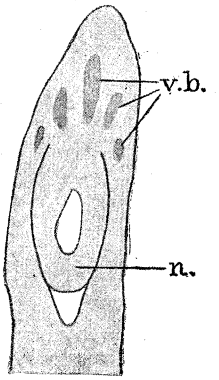


FIG. 20.

FIG. 18.—Vertical Section through Nucellar Portion of Ovule, cut at right angles to the median plane, and passing through the micropyle. *v.b.*, vascular bundle; *a*, portion of a branch of the vascular bundle. × 46.

FIG. 19.—Median Section through Nucellar Region of a slightly older Ovule, showing the vascular tissue (shaded) and the position of the embryo-sac (*e.s.*). × 46.

FIG. 20.—Oblique, but nearly Horizontal Section, cut at right angles to the median plane, in the same region of the ovule. *v.b.*, vascular bundles in chalazal region; *n.*, nucellus. × 46.

The main vascular bundle, in passing through the chalazal region, branches pinnately, and the separate branches run for some distance in the integument. This, of course, cannot be seen in median sections, like figs. 16, 17, and 19, but in fig. 20, which is cut at right angles to the median plane, the upper part of the section passes through the chalazal region, and shows five vascular bundles (*v.b.*) derived from the original bundle by branching.

The youngest ovule examined was $\frac{2}{3}$ mm. in its greatest diameter. At this stage the appendage (fig. 21, *a*) of the funicle is still quite small, and the nucellus (*nu.*) is vertical. The diagram is from a series of microtome sections, in which the tissues were rather contracted, so the form of the ovule cannot be taken as perfectly accurate.

The contents of the embryo-sac were usually contracted or otherwise not in very good condition, hence a detailed description cannot be given. There appeared to be a normal egg-apparatus of three cells, and a conspicuous nucleus, presumably derived from the fusion of the polar nuclei, was seen in the middle of the embryo-sac. An early stage of endosperm-formation was also seen in two or three cases, numerous free nuclei being scattered in the parietal layer of protoplasm. It is therefore probable that there is no anomaly, except perhaps in the antipodal cells, of which more than three appeared to be present at a rather late stage.

The oldest ovule examined was about 6 mm. in its longest diameter, and roughly reniform, its general structure being much as in fig. 16. A section through the nucellar region of this ovule is shown in fig. 22. A young embryo (*e.*) is present, the

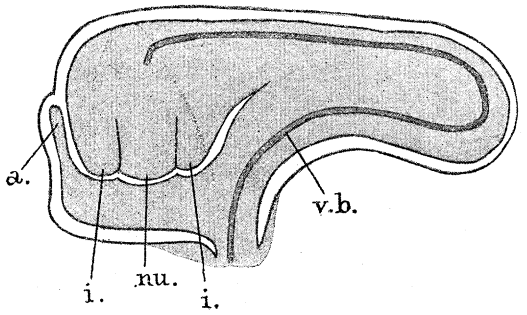


Fig. 21.

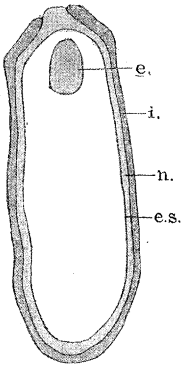


Fig. 22.

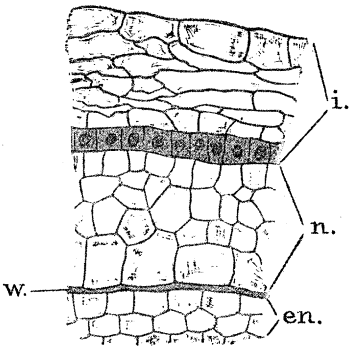


Fig. 23.

Fig. 21.—Median Section of young Ovule. *v.b.*, vascular bundle; *a.*, appendage; *i.*, integument; *nu.*, nucellus. × 90.

Fig. 22.—Section through Nucellar Region of old Ovule. *i.*, integument; *n.*, nucellus; *e.s.*, embryo-sac; *e.*, embryo. × 18.

Fig. 23.—Portion of same Section, to show the differentiation of the innermost layer of the integument. *i.*, integument; *n.*, nucellus; *w.*, wall of embryo-sac; *en.*, endosperm. × 390.

nucellus (*n.*) has not yet been absorbed, and the embryo-sac (*e.s.*) is filled with endosperm, which is not indicated in the diagram. The more central part of the endosperm consists of very delicate tissue. A portion of the same section, magnified to show the structure of the integument, etc., is represented in fig. 23. The cell-contents in the integument, nucellus, and endosperm (*i.*, *n.*, and *en.*) are omitted, except in the innermost layer of the integument, in which the cells have an epithelial character.

VI. Descriptio ordinis Julianiaceæ, Hemsley.

(Olim Amphipterygiaceæ, Hemsley et Rose.)

Flores dioici, parvi, inconspicui, hirsuti, cum foliis deciduis coætanei, masculi a femineis diversissimi. *Flores masculi* iis *Quercus* sectionis *Lepidobalani* specierum nonnullarum simillimi, in amenta vel racemos ramosos vel interdum simplices axillares dispositi, ramulis pedicellisque capillaribus pubescentibus. *Perianthium* simplex, tenuissimum, extus parce pilosum, 3–9-partitum, vel interdum imperfectum, segmentis linearibus inter se æqualibus. *Stamina* tot quot perianthii segmenta, iisque alterna; filamenta brevia, filiformia; antheræ oblongæ, biloculares, pilis longiusculis parce vestitæ, rimis longitudinalibus late dehiscentes. *Pollinis grana* J. adstringentis globosa, circiter 35μ diametro, minutissime reticulata. *Gynæcii rudimentum* nullum. *Flores feminei* terni vel quaterni, involucro fere clauso inclusi, collaterales, 2 laterales sæpius (an semper?) imperfecti, sessiles, inter se liberi, marginibus involucro adnati. Involucra juvenilia erecta, cum pedicellis continua per anthesin inconspicua, lineari-

lanceolata, compressa, pubescentia, 15 ad 20 mm. longa, 2 ad 3 mm. lata, apice 3–5-dentata, in pedunculis axillaribus primum brevissimis sæpius bina, vel nunc solitaria nunc terna, basi unibracteata, ante embryonis evolutionem valde aucta. *Perianthium* nullum. *Staminodia* nulla. *Ovarium* cartilagineum, puberulum, uniloculare, loculo angustissimo uniovulato; stylus conspicuus, alte tripartitus, ex involucri orificio exsertus; rami spathulati, recurvi, apice emarginati, intus canaliculati, læves, glabri, extus pubescentes; florum lateralium styli sæpissime imperfecti, inclusi vel omnino deficientes. Ovulum *Julianiæ* solitarium, hemianatropum integumento unico, in funiculo insigniter appendiculato a loculi basi ascendente; funiculus (an placenta?) ovuli novelli hippocrepiformis vel cordatus, complanatus, loculo conformis, 2 ad 3 mm. latus, deinde oblongus, apice æqualiter vel inæqualiter bilobatus (an semper?), lobo ovulifero nervo margini approximato percurso, altero sterili enervi forma variabili in latere cum ovulo contiguo diverse excavato et ovulum magis minusve recipiente demum omnino evanascente; ovuli evolutio post embryonis initiam ad maturitatem nondum rite observata. Ovulum *Orthopterygii* imperfecte cognitum sed ei *Julianiæ* persimile videtur, ab eo tamen insertione laterali recedit; funiculus supra basin cupulatim dilatatus, abhinc excavatus, bilamellatus et ovulum pendulum recipiens. *Fructus* compositus, siccus, indehiscens, cum pedicello dilatato complanato tenui 4 ad 7 cm. longus, apice incrassatus, subglobosus, lævis, e pedunculo demum elongato pendulus; ala tenuis, e basi cuneata sensim oblique vel æquilateraliter dilatata. *Nuces* fere orbiculares, complanatæ, biconvexæ, inter se liberæ, involucri parietibus adnatæ; pericarpium sclerenchymaticum, durissimum, extus hirsutum. Semen *Julianiæ* solitarium, e funiculo basilari suspensum, exalbuminosum, circiter 6 mm. diametro maximo, inappendiculatum, reniforme vel rotundatum; testa tenuis, lævis. *Embryo* horizontalis, circiter 7 mm. longus; radicula elongata, adscendens, cotyledonibus plano-convexis obliquis accumbens; cotyledones in germinatione epigææ. Arbusculæ et frutices Americani, Mexici et Peruviæ incolæ, dioici, resiniferi, adspectu *Burseræ* specierum nonnullarum, tortuoso-ramosi. Folia decidua, alterna, exstipulata, imparipinnata, ad apices ramulorum hornotinorum floriferorum conferta, vel in ramis sterilibus sparsa interdumque unifoliolata; foliola opposita, exstipellata, diverse dentata. Flores inconspicui, virides, masculi racemoso-paniculati, feminei plures in receptaculis clausis aggregati. Fructus compositus, samaroideus, indehiscens.—Genera 2.

Ordo naturalis nulli arcte affinis. Arbusculæ et frutices habitu foliisque *Burseraceis* et *Anacardiaceis* nonnullis similes, floribus ad Cupuliferares magis accedentes. Insuper ductis resiniferis, ovulo, semine, embryoneque *Anacardiaceas* arcte accedit; flores masculi cum illis *Quercus* omnino convenientes; flores feminei more Castaneæ involucro clauso inclusi; denique styli ut in *Juglandaceis* late lobulati.

Juliania, Schl., in 'Linnæa,' vol. 17 (1843), p. 746. (*Hypopterygium*, Schl., in *op. cit.*, p. 636). Folia matura sæpius ampla. Inflorescentia mascula multiramosa, pendula. Inflorescentiæ femineæ sæpius binæ vel ternæ, pedunculo communi

demum plus minusve elongato. Florum musculinorum perianthium bene evolutum, 5–8-partitum, segmentis stamina excedentibus. Florum femineorum involucrum sæpius (an semper ?) 4-florum, floribus 2 lateralibus sæpius (an semper ?) abortientibus ; pedicelli sursum sensim dilatati, sæpius obliqui, inæquilaterales, circiter ter longiores quam lati. Styli rami ex involucri orificio longe exserti. Semen in loculi fundo affixum.

Species quatuor, Mexici centralis et australis incolæ.

1. *J. adstringens*, Schl., in *op. sup. cit.*, p. 746. Hemsley, in 'Hook. Ic. Pl.,' t. 2723. Foliola sæpius 5 vel 7, obovata vel oblanceolata, supra medium latiora. *Amphipterygium adstringens*, Schiede ex Schl., *loc. cit.*, p. 746, Hemsley & Rose, in 'Ann. Bot.,' vol. 17, p. 444.—Plates 1, 2, & 5.

2. *J. mollis*, Hemsley, in 'Hook. Ic. Pl.,' t. 2722. Foliola 3 vel 5, oblonga vel ovato-oblonga, crassa, omnino velutino-tomentosa, albida. *Amphipterygium molle*, Hemsley & Rose, *loc. cit.*, p. 444.

3. *J. amplifolia*, Hemsley & Rose, in 'Ann. Bot.,' vol. 17, p. 444. Foliola sæpius 7 vel 9, lanceolata, acuminata, $2\frac{1}{2}$–4 poll. longa, infra medium latiora. *Amphipterygium amplifolium*, Hemsley & Rose, *loc. cit.*—Plates 3, 4, & 5.

4. *J. glauca*, Hemsley & Rose, *loc. cit.*, p. 444. Foliola 3 vel 5, undique glabra, subtus glauca, petiolo communi gracillimo. *Amphipterygium glaucum*, Hemsley & Rose, *loc. cit.*—Plate 6.

Orthopterygium, Hemsley, genus novum. Folia matura parva. Inflorescentia mascula parva, erecta. Inflorescentia feminea solitaria, pedicello fere ad basin æqualiter complanato. Florum masculorum perianthium sæpius 4-partitum, interdum imperfectum, segmentis quam staminibus brevioribus. Florum femineorum involucrum, ut videtur, 3-florum, floribus 2-lateralibus abortientibus; pedicelli recti, æquilaterales, angusti, semper plus quam sexies longiores quam lati. Styli breviter (?) exserti. Semen ad loculi latus affixum.

Species unica, Peruviæ occidentalis incola.

O. Huaucui, Hemsley. *Juliania Huaucui*, A. Gray, in 'Bot. U.S. Expl. Exped.,' vol. 1, p. 371. *Amphipterygium Huaucui*, Hemsley & Rose, in 'Ann. Bot.,' vol. 17, p. 445.—Plate 7.

VII. The Affinities of the Julianiaceæ.

During the six years that I have had this small group under observation, I have had opportunities of showing the specimens and drawings to many of the leading botanists of the world, and all agree who have seen them that it deserves to rank as an independent order. That being so, the question of its position arises, but this is a point not so easily settled in a linear arrangement. Taking the morphological characters seriatim, it is evident that the closest relationships are with the Anacardiaceæ and Cupuliferæ. The absolute separation of the sexes, and the very great diversity of the floral structure of the sexes, associated with pinnate leaves, offers a combination of characters probably without a parallel.

Beginning with the foliage, the Julianiaceæ have alternate, exstipulate, impari-pinnate leaves in common with at least eight different ligneous orders, but here the affinity, or rather resemblance, ends, so far as six of them are concerned, and the comparisons need be carried no further. There remain the Anacardiaceæ and Juglandaceæ, both of which are also resiniferous, both have unisexual flowers with reduced envelopes, at least as to some of their members, and both have solitary, exalbuminous seeds. Other points of resemblance or similarity in the Juglandaceæ are the dissimilar male and female flowers, the broad stigmatic lobes of the style, and the single-coated ovules. *Juglans* has also a funicle of unusual development. But the characters in common of the Julianiaceæ and the Juglandaceæ cannot be regarded as constituting a close affinity.

In many respects there is a nearer relationship to the Anacardiaceæ. The anatomical characters of the two orders are very much alike; but as Dr. F. E. FRITSCH will describe and discuss the anatomy in a separate paper, it is unnecessary to enter into particulars here. In describing the ovule of the Julianiaceæ at p. 184, it is stated that the nearest approach we have found to the singular funicular development is in the Anacardiaceæ, but the resemblance is remote and the ovules of the latter are double-coated. Coming to the seed and the embryo, however, the resemblance is complete, and apart from the slight obliquity of the cotyledons of *Juliania*, the description of the seed and embryo of *Cotinus* or *Rhus* would do equally well for *Juliania*. With this the affinities to the Anacardiaceæ are exhausted, and they are not sufficiently strong, in my opinion, to justify the juxta-position of the two orders. The next comparison is with the Cupuliferæ, taking the order as limited by BENTHAM and HOOKER. There is nothing in the secretions nor in the foliage to warrant an approximation of the two orders, and in habit of growth the Julianiaceæ are very different. But divergences as great, or greater, exist between closely associated orders, and even between genera referred to the same order; and when we come to the inflorescence and flowers, affinities are evident; that is if affinities are deducible from similarities in structure.

The male inflorescence, the male flowers and the pollen of *Juliania adstringens* are so near in texture, structure and form to the same parts in certain species of oak that, detached, they might be referred to the genus *Quercus*. In fact, there is much greater dissimilarity in the male inflorescences and flowers of different species of *Quercus* than there is between those of *Juliania* and those species of *Quercus* which have a flaccid male inflorescence and stamens alternating with the segments of the perianth.

The female inflorescence and the female flowers of *Juliania* are not represented by exact counterparts in the Cupuliferæ, but the analogies are perhaps greater than with any other order. Several female flowers, in a closed involucre, is a characteristic of *Juliania*, of *Fagus*, *Castanea* and *Castanopsis*. In all three of the genera of the Cupuliferæ named the involucre dehisces regularly or irregularly, and the nuts fall

out. In *Juliania* the involucre is indehiscent, and the flattened nuts are adnate by their edges to the inner wall of the involucre, and they have a very hard, relatively thick, sclerenchymatous pericarp.

Going back to the flowers, the male of *Juliania* has a perianth; the female none. In *Corylus* the conditions are reversed; in *Betula* neither has an obvious perianth; in *Quercus* the flowers of both sexes are furnished with a perianth.

All of the Cupuliferæ have an ovary which is more than one-celled, and usually there are three cells, and mostly more than one ovule in each cell, though each nut is usually only one-seeded. The ovaries of *Juliania* and of *Orthopterygium* invariably contain only one ovule. The flowers and nuts of *Castanea* are collateral, as in *Juliania*. The seeds of both *Juliania* and the Cupuliferæ are exalbuminous, and the cotyledons are epigæous in germination.

Weighing the characters of the reproductive organs in which there is agreement or similarity between the Julianiaceæ and the Anacardiaceæ, and those in which there is agreement or similarity between the Julianiaceæ and the Cupuliferæ, the latter, in my estimation, preponderate; and I cannot suggest a more natural position for the Julianiaceæ than between the Juglandaceæ and the Cupuliferæ. In this view I am supported by my colleague, Dr. O. Stapf.

On the other hand, if anatomical characters, coupled with the nature of the secretions, are to be credited with superior claims in classification, then the Julianiaceæ would have to be placed next to the Anacardiaceæ.

VIII. Concluding Remarks.

I have received so much help in elucidating this singular group of plants, both from my immediate colleagues and other botanists, that I feel that I cannot conclude without naming those to whom I am more especially indebted. I have already referred to the generous act by which Dr. J. N. Rose placed all his material at my disposal, and I have reproduced his field notes in full or with slight modifications to bring them in harmony with my plan of dealing with the materials. The original idea was to work jointly, and diagnoses of the species were published under both names, though I am responsible for their final form. Apart from Dr. Rose's notes, and Mr. Boodle's description of the ovule, I am also responsible for the whole of the present paper, but I have reasons for believing that Dr. Rose is now in agreement with me on all points of importance. Although I am primarily indebted to Dr. Rose for the loan of the specimens belonging to the United States National Museum at Washington, my thanks are also due and offered to Mr. S. P. Langley, Secretary to the Smithsonian Institution, who kindly sanctioned their being sent to Kew.

In the next place, I should like to record my gratitude to the Trustees of the Bentham Fund for the advancement of Botany, for defraying the cost of the drawings,

so excellently executed by Miss M. SMITH, whose skill and patience in floral dissection is unsurpassed. Her drawings include sketches of all the specimens lent by the United States National Museum, besides numerous details not reproduced in the accompanying plates. All these drawings are preserved at Kew.

Of my colleagues, I am more especially indebted to Dr. O. STAPF, for active help and suggestions during the whole time I have been engaged in these investigations; to Mr. G. MASSEE, for drawings of the pollen; and to Mr. L. A. BOODLE, who furnished the drawings and descriptions of the young embryo, reproduced at p. 185. I also wish to record my thanks to Professor ED. BUREAU and Mr. JULES POISSON, of Paris, and Professor Dr. A. ENGLER, of Berlin, for the loan of specimens; and to Dr. R. PILGER, of Berlin; to Dr. A. ZAHLBRUCKNER, of Vienna, and Dr. C. MEZ, of Halle, for their endeavours to find SCHIEDE's original specimens.

Dr. ROSE reminds me, too, that we owe much to Mr. C. G. PRINGLE's exertions. He has collected copious material, and he first discovered *Juliania mollis* and *J. amplifolia*.

It was originally intended to present the results of Dr. FRITSCH's anatomical investigations as a supplement to this paper; but having recently received further material in spirit, he wishes to go over some of his work again.

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PLATE 18.

Juliania adstringens, SCHL.

Fig. 1.—A branch bearing ♂ flowers. Natural size. PRINGLE, 7243.

Fig. 2.—A ♂ inflorescence. Natural size. PRINGLE, 8533.

Fig. 3.—A heptamerous ♂ flower. About × 10. PRINGLE, 8533.

Fig. 4.—A hexamerous ♂ flower. About × 10. PRINGLE, 7243.

Fig. 5.—A pollen grain. About × 400. PRINGLE, 8533.

Fig. 6.—A portion of the surface of the same. × 1000.

Fig. 7.—A pair of ♀ inflorescences, one of which has two fully developed flowers with exserted styles, the other only one. About × 3. ROSE and HAY, 5341.

Fig. 8.—A longitudinal section of a ♀ inflorescence, showing portions of four flowers, the two lateral having imperfectly developed styles. About × 5. ROSE and HAY, 5341.

Fig. 9.—A longitudinal section through the broad plane of an ovary, showing the solitary, basal ovule. About × 4. ROSE and HAY, 5341.

Fig. 10.—The same ovule. About × 6.

PLATE 19.

Juliania adstringens, SCHL.

Fig. 1.—A branch bearing young leaves and ♀ flowers. Natural size. ROSE and HAY, 5341.

Fig. 2.—A branch bearing ripe fruit. Natural size. ROSE and PAINTER, 6550.

Fig. 3.—A longitudinal section of an imperfect infrutescence, showing oblique position of empty carpels. About × $2\frac{1}{2}$. LANGLASSÉ, 319, *bis*.

Fig. 4.—A longitudinal section of an imperfect infrutescence of the same specimen as the last, showing a grown-out ovule without any development of embryo, probably because unfertilised.

Fig. 5.—A cross-section of a ripe fruit through the seeds of the two fertile flowers. About × 3. NELSON, 1706.

Fig. 6.—A ripe seed. Natural size. ROSE and PAINTER, 6550.

Fig. 7.—An embryo from the same specimen. About × 3.

PLATE 20.

Juliania amplifolia, HEMSLEY and ROSE.

Fig. 1.—A branch bearing half-ripe fruit. Natural size.

Fig. 2.—Upper portion of half-ripe fruit, bearing the free tips of the involucral bracts and the remains of the styles. About × 3.

Fig. 3.—Remains of a style below the free stigmatic arms. About × 5.

Fig. 4.—A section of a half-ripe carpel, showing a grown-out ovule without any obvious development of embryo. About × 2.

Fig. 5.—The same ovule, showing a groove on the outer edge of the funicular appendage.

Fig. 6.—An ovule. Natural size.

Fig. 7.—The same enlarged.

Fig. 8.—The same, showing a groove on the inner margin of the funicular appendage.

Fig. 9.—A cross-section of fig. 5 below the embryonal lobe.

Fig. 10.—An ovule, in which the funicular appendage is folded back on the embryoniferous part. About × 3.

All from ROSE and HAY, 4819.

PLATE 21.

Juliania amplifolia, HEMSLEY and ROSE.

Fig. 1.—A branch bearing ripe fruit. Natural size.

Figs. 2, 3, and 4.—Cross-sections, at different heights, of a ripe fruit, showing the seeds in the central carpels, and malformed growths in the lateral ones. About × $2\frac{1}{2}$.

Fig. 5.—A ripe seed. About × 5.

Fig. 6.—A section of a seed through its greatest diameter, showing accumbent radicle.

Fig. 7.—An embryo. Natural size.

Fig. 8.—The same. About × 6.

All from PRINGLE, 5002.

PLATE 22.

Juliania adstringens, SCHL.

Fig. 1.—A seedling in an early stage. Natural size. ROSE and HAY, 5341.

Fig. 2.—A barren shoot bearing simple and trifoliolate leaves. Natural size. ROSE and PAINTER, 6550.

Fig. 3.—Peduncle bearing three fruits. ROSE.

Figs. 4 and 5.—Superficial and sectional views of old bark. Natural size. ROSE and PAINTER, 6550.

Juliania amplifolia, HEMSLEY and ROSE.

Fig. 6.—Fruiting branch after the fall of the leaf. Natural size. ROSE and PAINTER, 7425.

PLATE 23.

Juliania glauca, HEMSLEY and ROSE.

Fig. 1.—Branch bearing ripe fruit, after the fall of the leaf. Natural size.

Figs. 2 and 3.—Detached leaves. Natural size.

Fig. 4.—Top of fruit, enlarged one-half.

Fig. 5.—Cross-section of a fruit, showing the seed in two ovaries. No trace of lateral flowers. About × 2.

Fig. 6.—A nut denuded of its epicarp. About × 4.

Figs. 7 and 8.—A seed, natural size and enlarged about three times.

Fig. 9.—An embryo in natural position. About × 5.

All from LUMHOLTZ, without number.

PLATE 24.

Orthopterygium Huaucui, HEMSLEY.

Fig. 1.—A branch bearing ♂ flowers. Natural size. MACLEAN.

Fig. 2.—A portion of a ♂ inflorescence from the same. About × 5.

Figs. 3 and 4.—Male flowers from the same. About × 8.

Fig. 5.—A perianth-segment from the same.

Fig. 6.—A more enlarged stamen from the same.

Fig. 7.—A branch. Natural size. MATHEWS, 591.

Fig. 8.—A branch bearing fruits, after the fall of the leaf. Natural size. MATHEWS, 591.

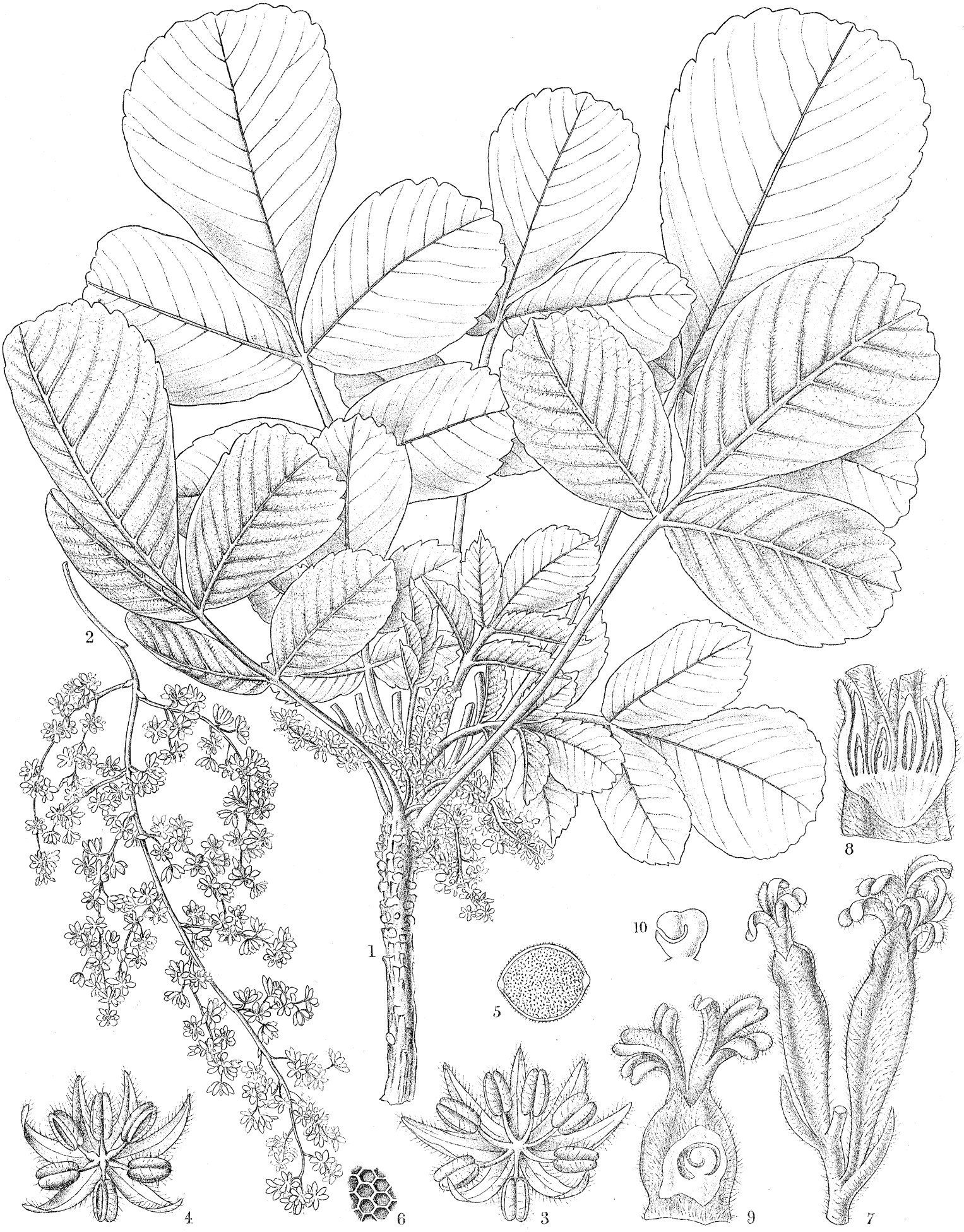
Fig. 9.—An imperfect fruit, from the same. Natural size.

Figs. 10, 11, and 12.—Views of the apex of imperfect fruits. About × 3.

Fig. 13.—Longitudinal section of an imperfect fruit, showing traces of three flowers, the central one fertile and the two lateral imperfect.

Fig. 14.—A longitudinal section of an ovary, showing the laterally adnate, bilamellate funicle, with a cup-like base, and the pendulous embryoniferous part of the ovule—partly diagrammatic. About × 6.

Fig. 15.—Diagrammatic cross-section of the middle of the last.



M. Smith, del.

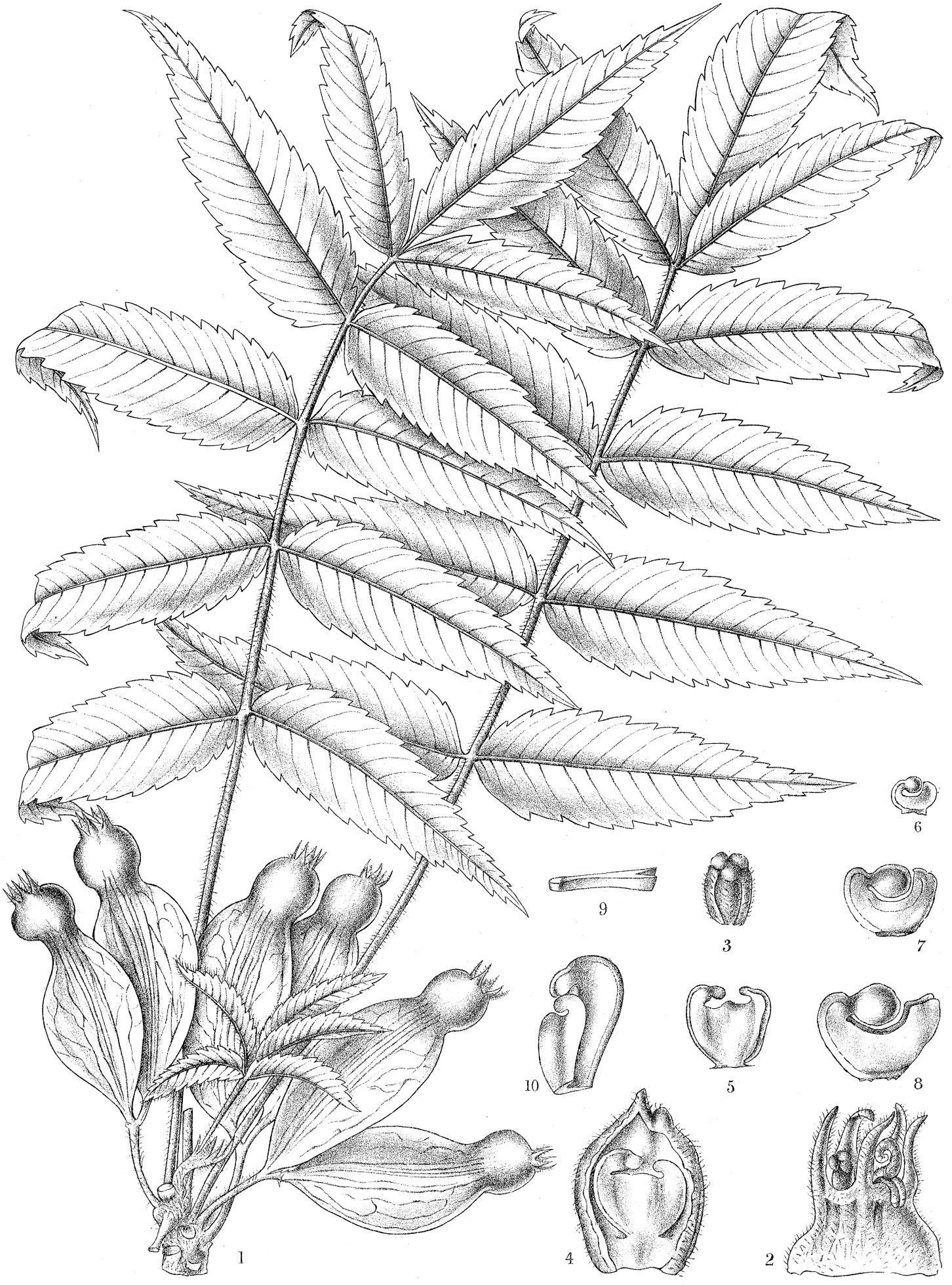
McFarlane & Erskine, Lith. Edin.

Juliania adstringens, Schl.

M. Smith, del.

M^cFarlane & Erskine, Lith. Edin^r

Juliania adstringens, Schl.



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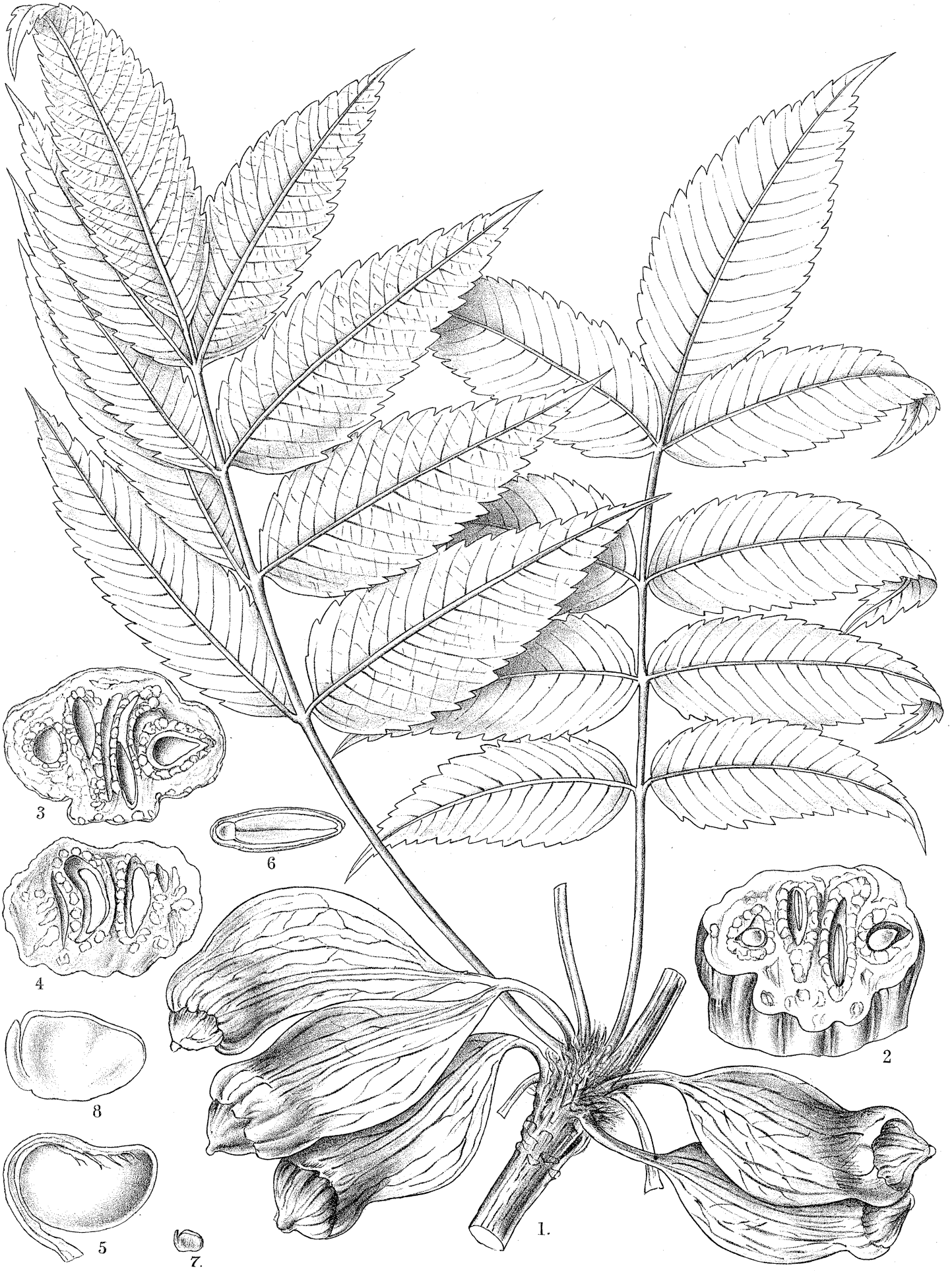
Juliania amplifolia, Hemsley & Rose.



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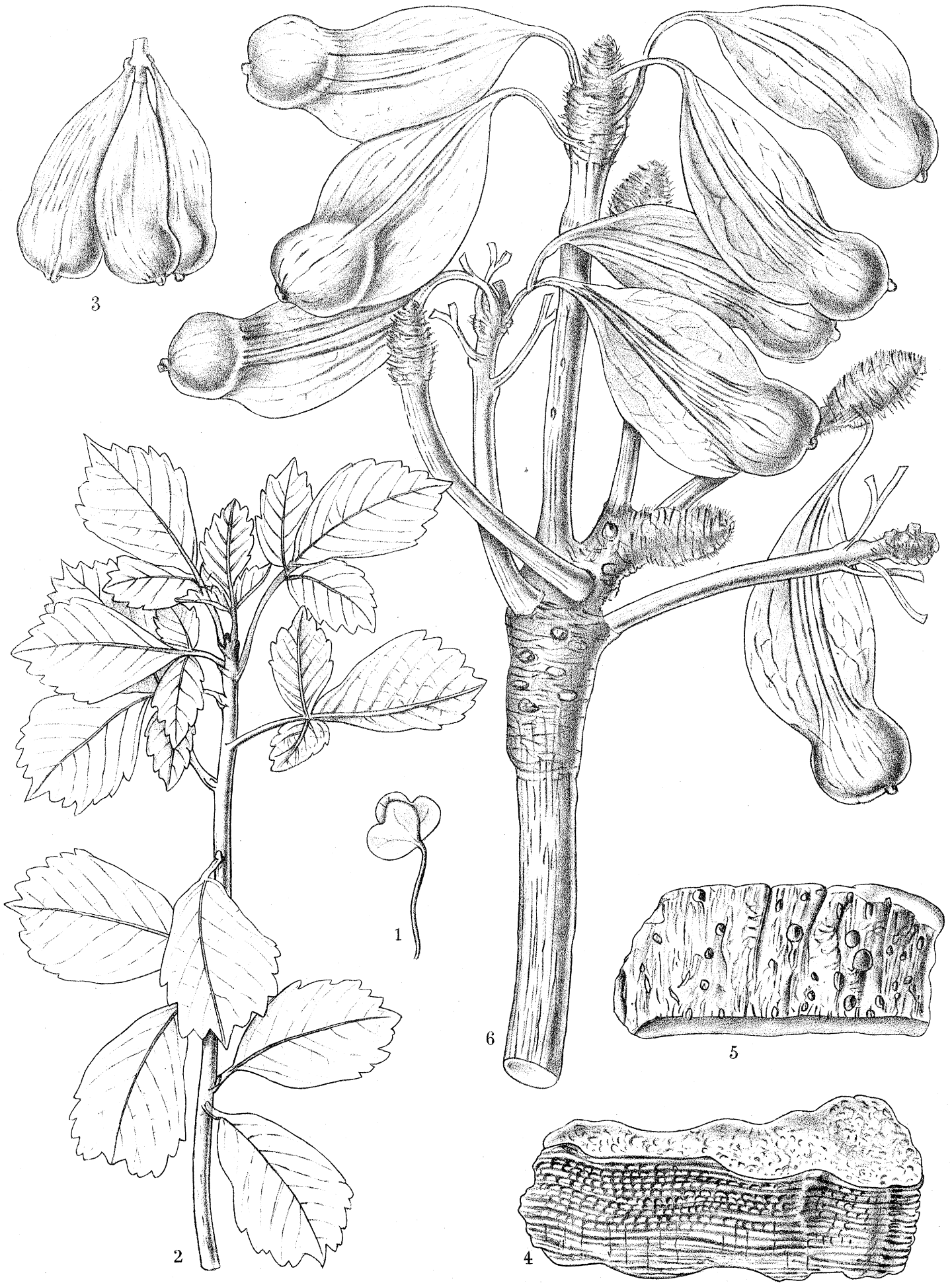

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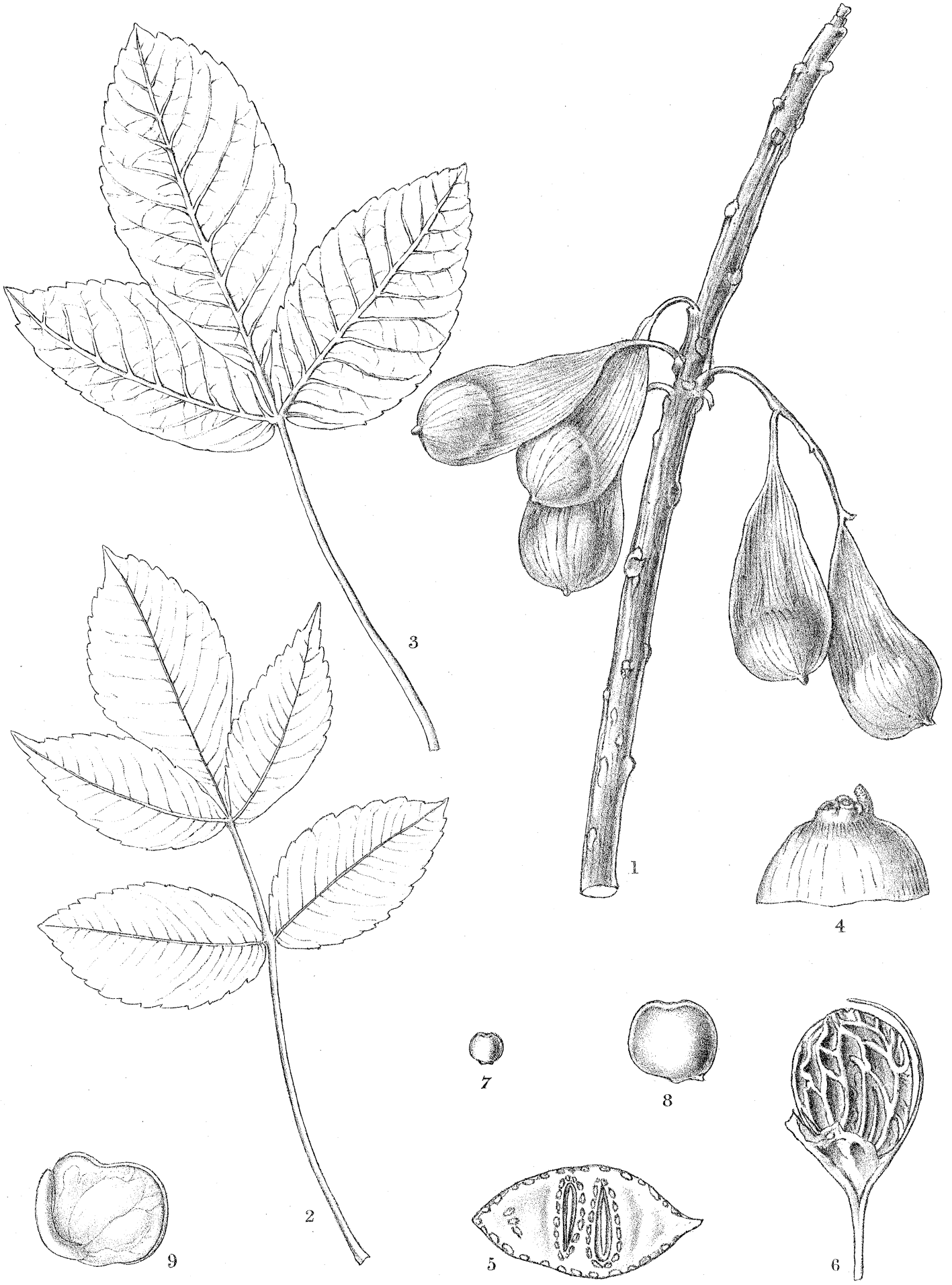
Figs. 1–5, Juliania adstringens, Schl. Fig. 6, Juliania amplifolia, Hemsley & Rose.



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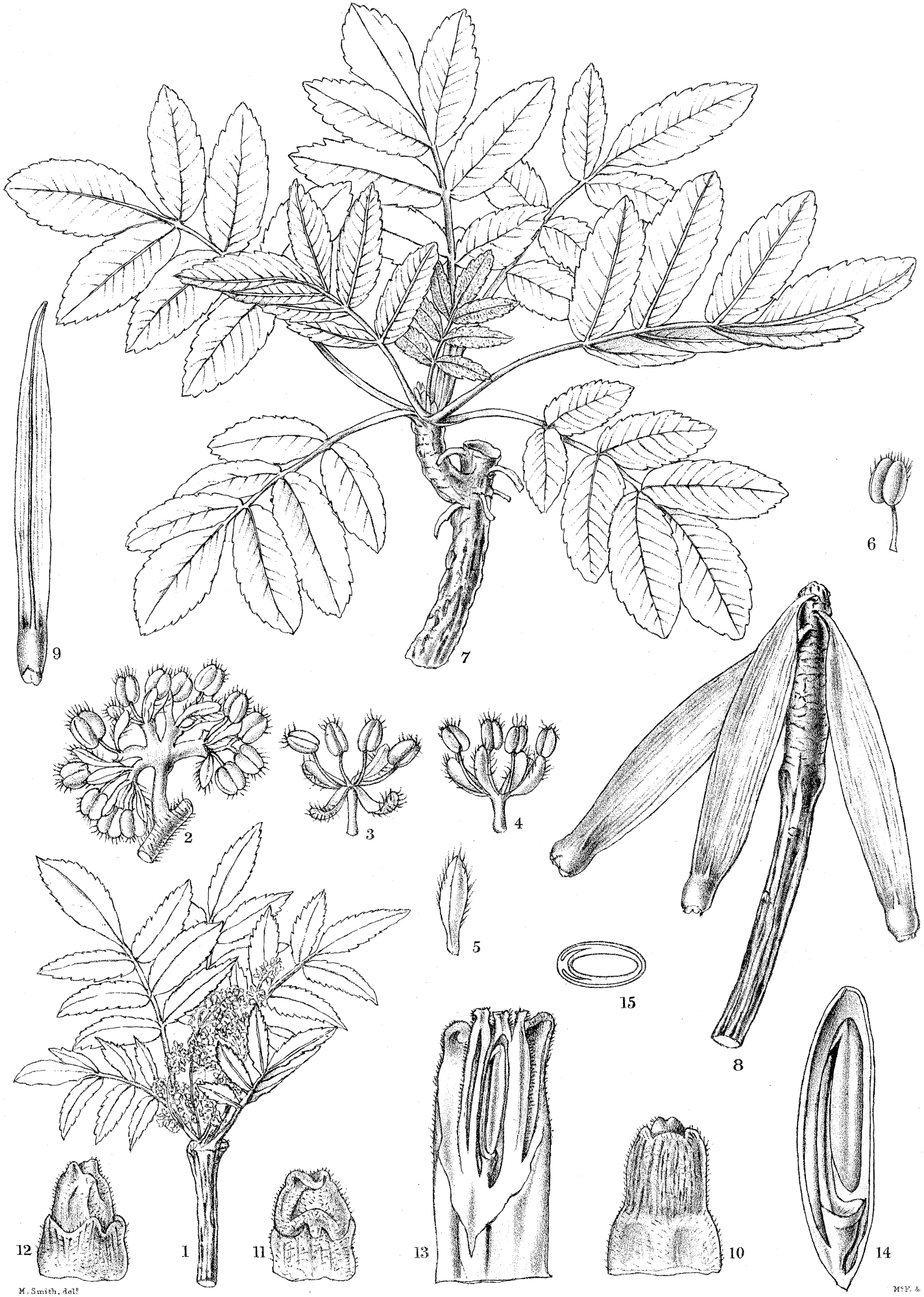
Juliania glauca, Hemsley & Rose.



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Orthopterygium Huaucui, Hemsley.

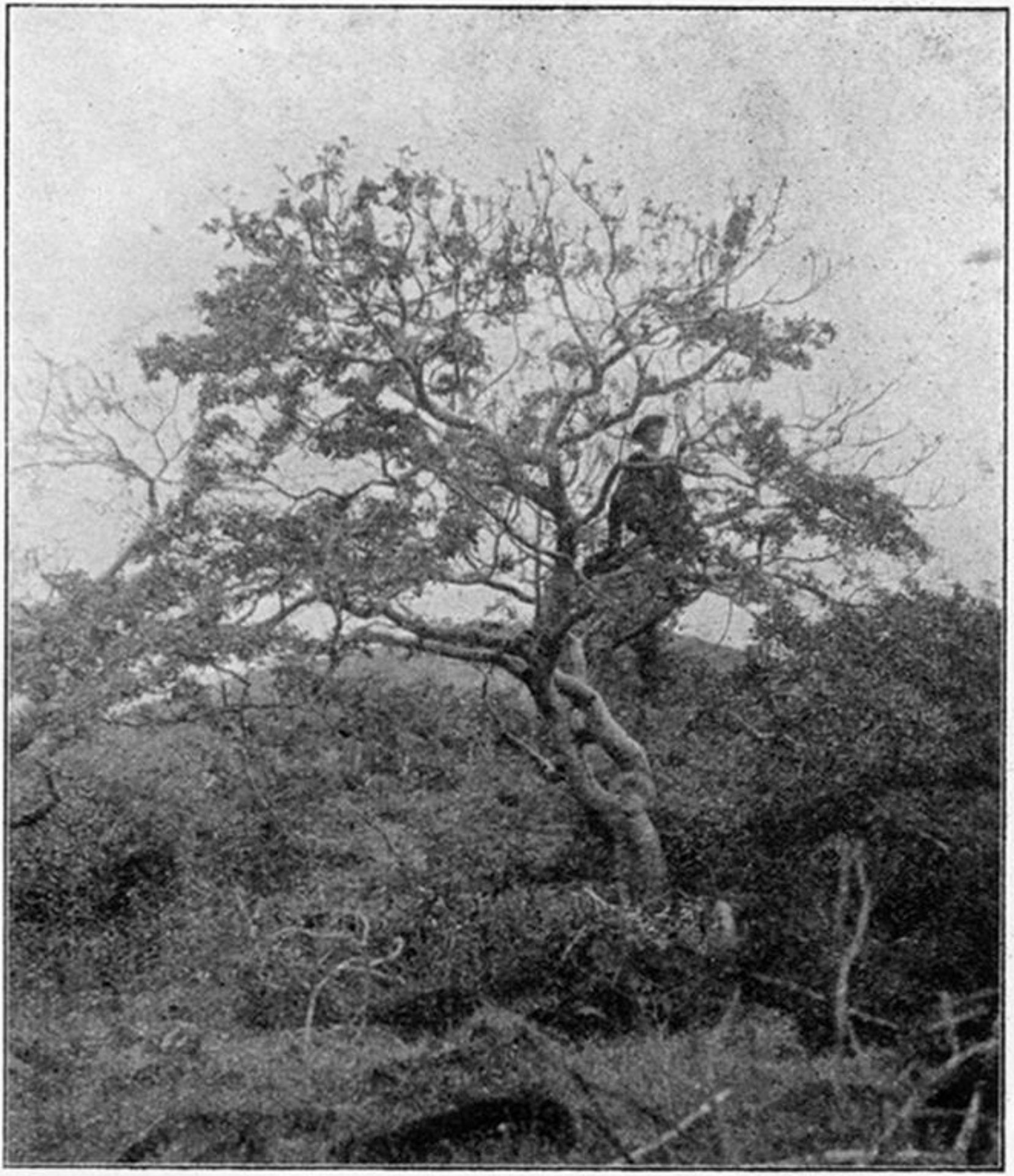


FIG. 1.—*Juliania adstringens.* The largest tree seen in fruit.

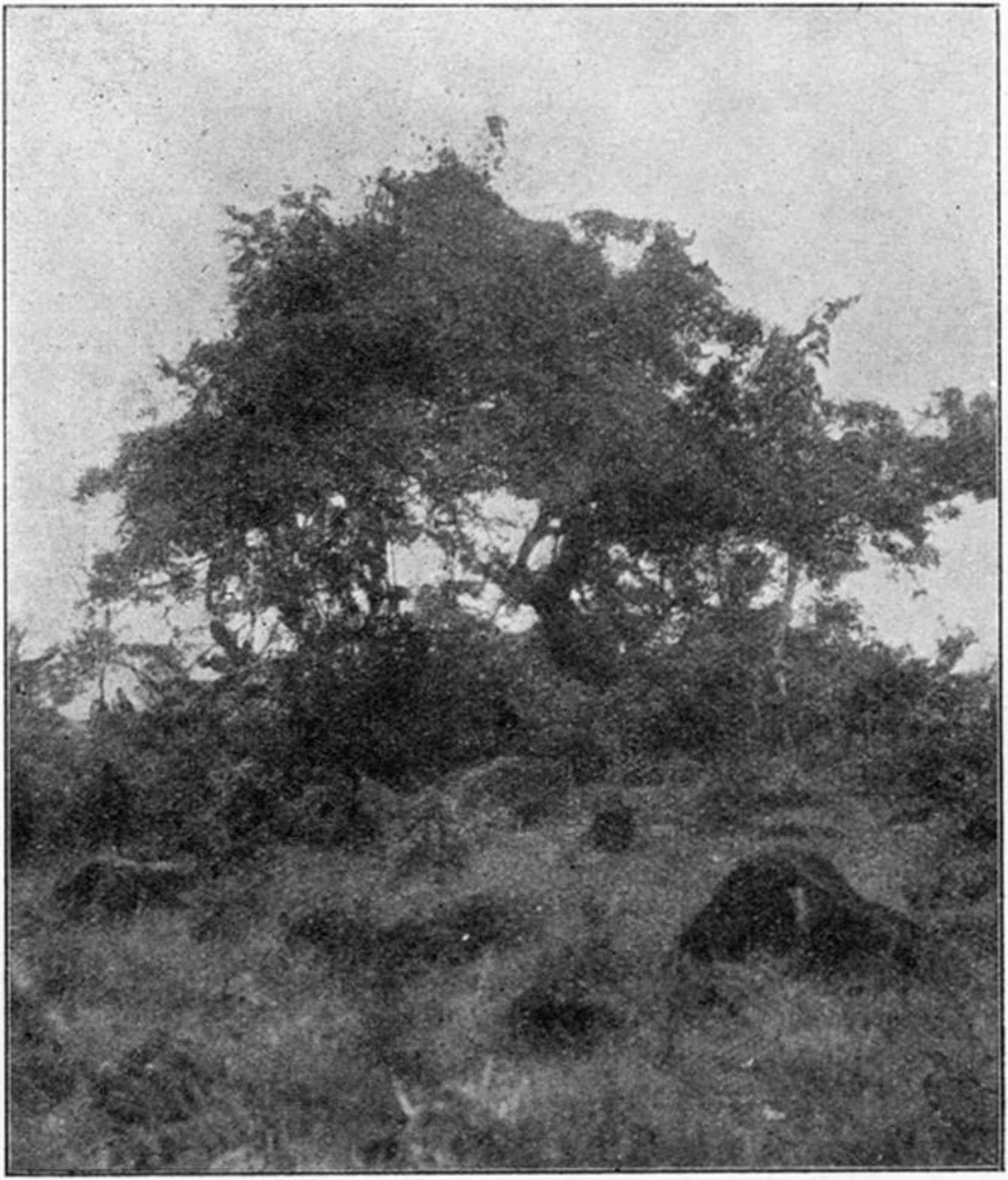


FIG. 2.—*J. adstringens.* A male tree in flower, over-run with vines.

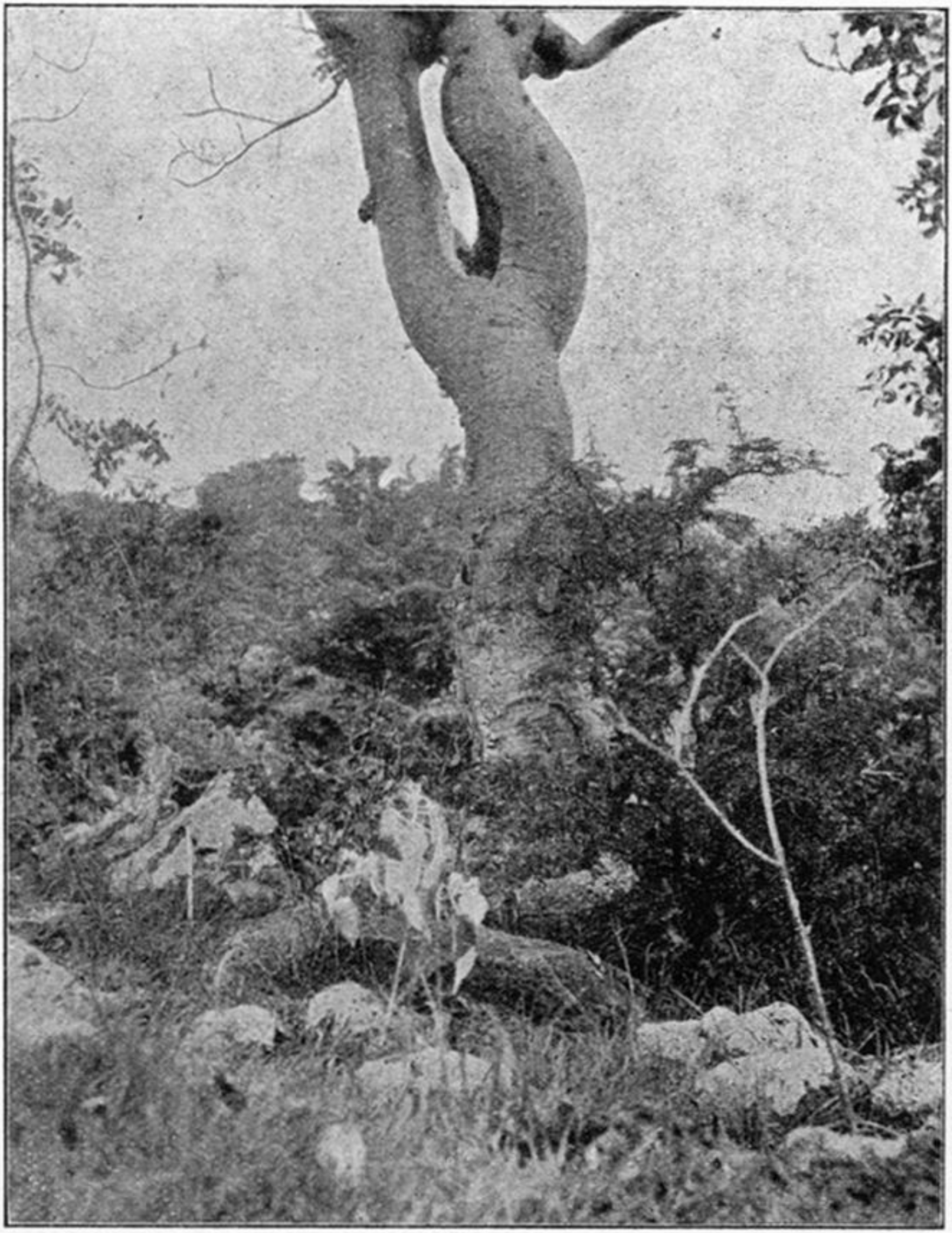


FIG. 3.—Trunk of fig. 1, 75 cm. in girth at about 1·2 m. from the ground.

FIG. 4.—Trunk of fig. 2, showing the stems of *Cissus*, *Hippocratea*, and *Pachyrhizus*, climbers, which over-run the top.

FIG. 5.—Lower part of Trees of *Juliania amplifolia*.

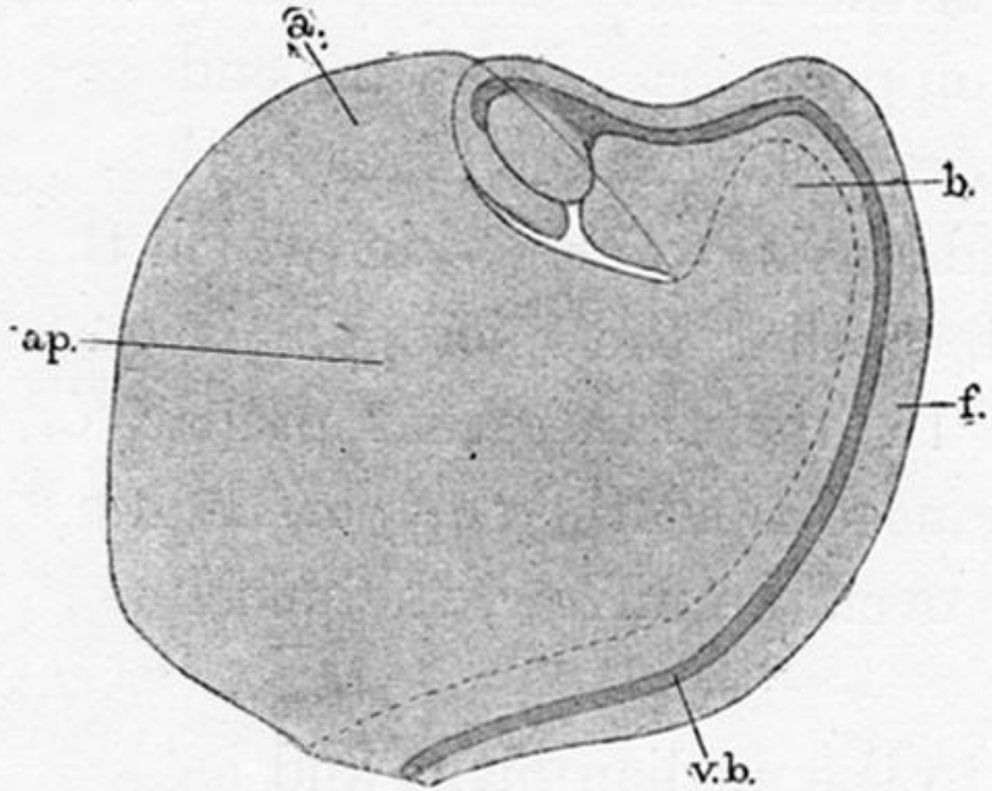


FIG. 16.

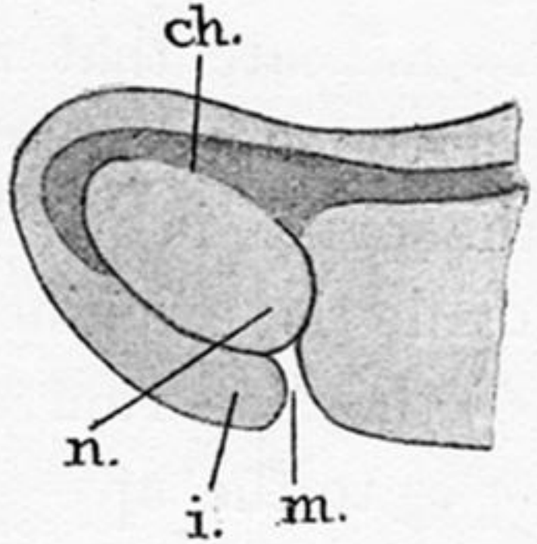
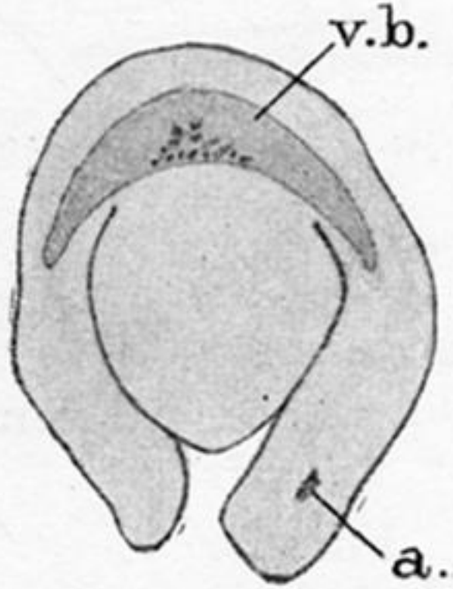
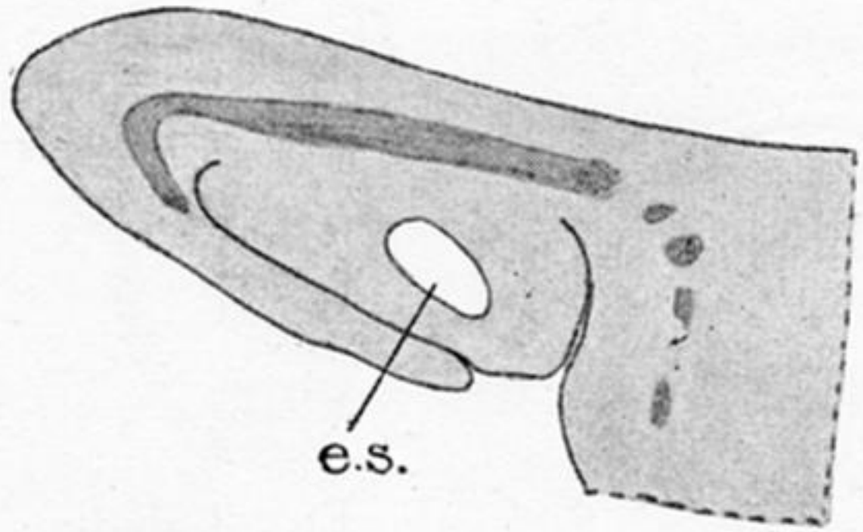


FIG. 17.

FIG. 16.—Ovule at the Fertilisation-stage, cleared in oil of cloves and seen in median optical section. *v.b.*, vascular bundle; *f.*, funicle; *ap.*, appendage of funicle. For explanation of *a* and *b*, see text. × 23.

FIG. 17.—Part of same Specimen, enlarged. *ch.*, chalaza; *n.*, nucellus; *i.*, integument; *m.*, micropyle. × 46.





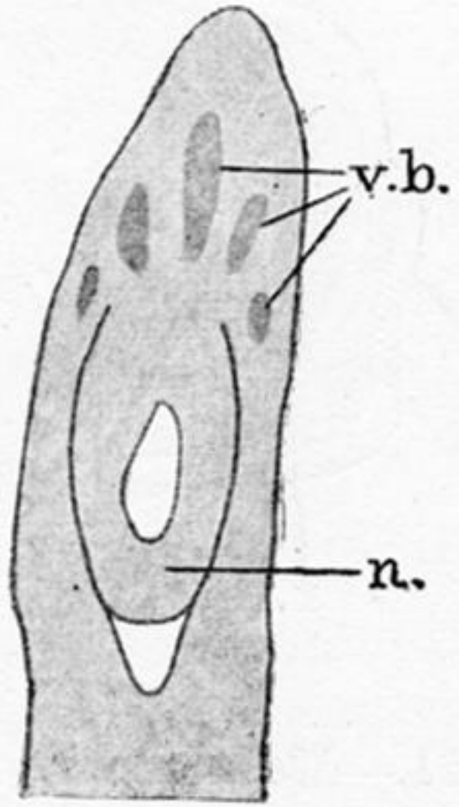


FIG. 18. FIG. 19 FIG. 20.

FIG. 18.—Vertical Section through Nucellar Portion of Ovule, cut at right angles to the median plane, and passing through the micropyle. *v.b.*, vascular bundle; *a*, portion of a branch of the vascular bundle. × 46.

FIG. 19.—Median Section through Nucellar Region of a slightly older Ovule, showing the vascular tissue (shaded) and the position of the embryo-sac (*e.s.*). × 46.

FIG. 20.—Oblique, but nearly Horizontal Section, cut at right angles to the median plane, in the same region of the ovule. *v.b.*, vascular bundles in chalazal region; *n.*, nucellus. × 46.

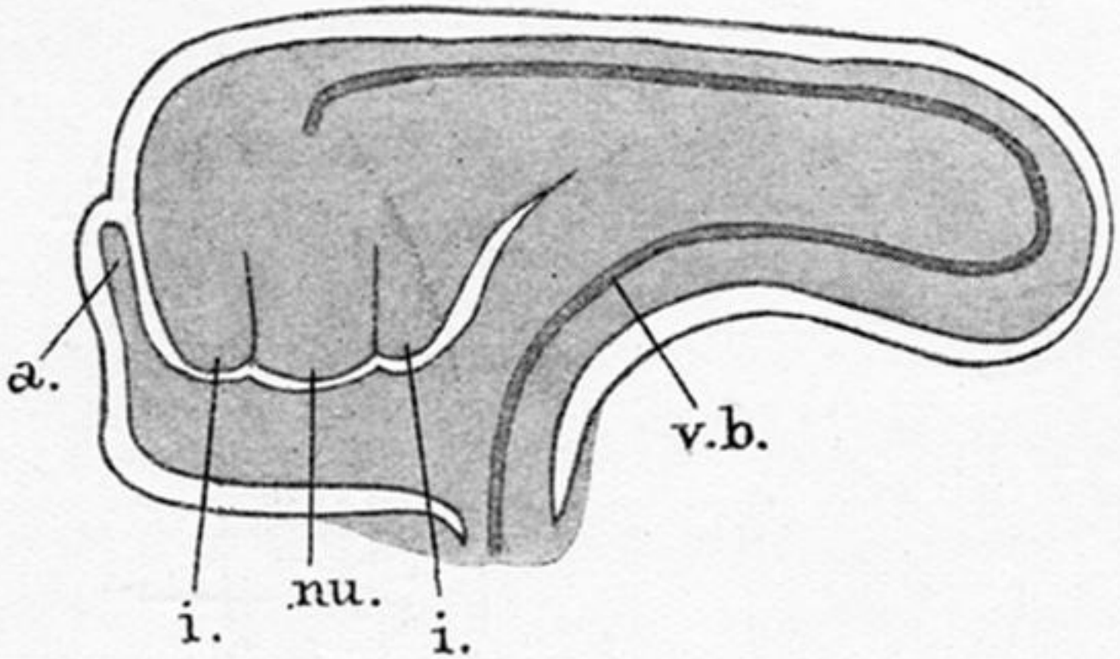


FIG. 21.

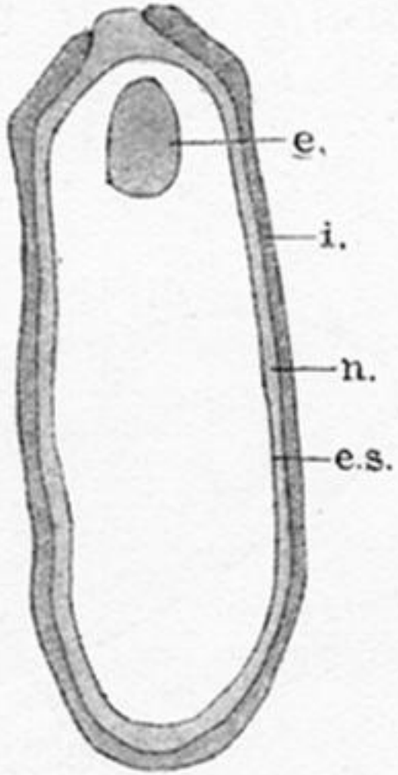


FIG. 22.

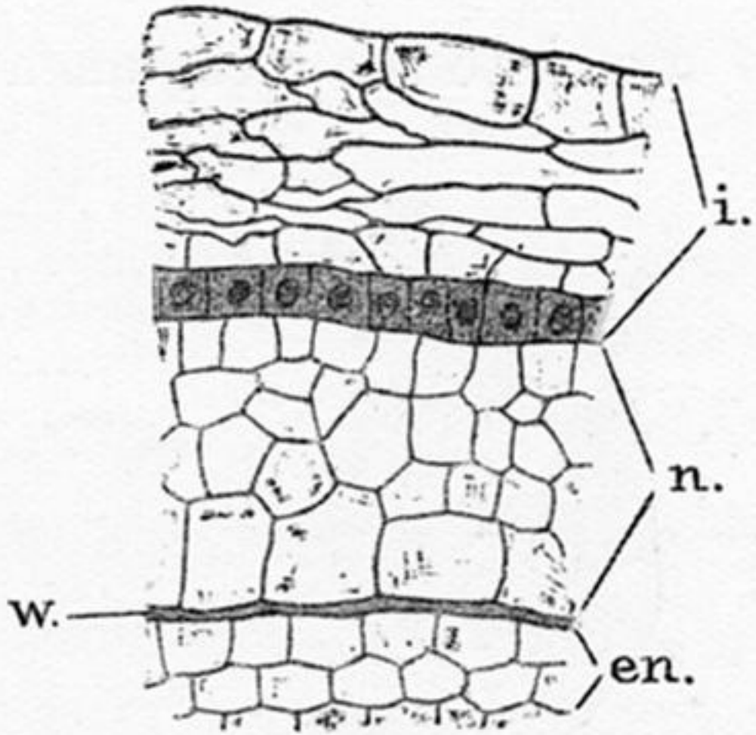


FIG. 23.

FIG. 21.—Median Section of young Ovule. *v.b.*, vascular bundle; *a.*, appendage; *i.*, integument; *nu.*, nucellus. × 90.

FIG. 22.—Section through Nucellar Region of old Ovule. *i.*, integument; *n.*, nucellus; *e.s.*, embryo-sac; *e.*, embryo. × 18.

FIG. 23.—Portion of same Section, to show the differentiation of the innermost layer of the integument. *i.*, integument; *n.*, nucellus; *w.*, wall of embryo-sac; *en.*, endosperm. × 390.

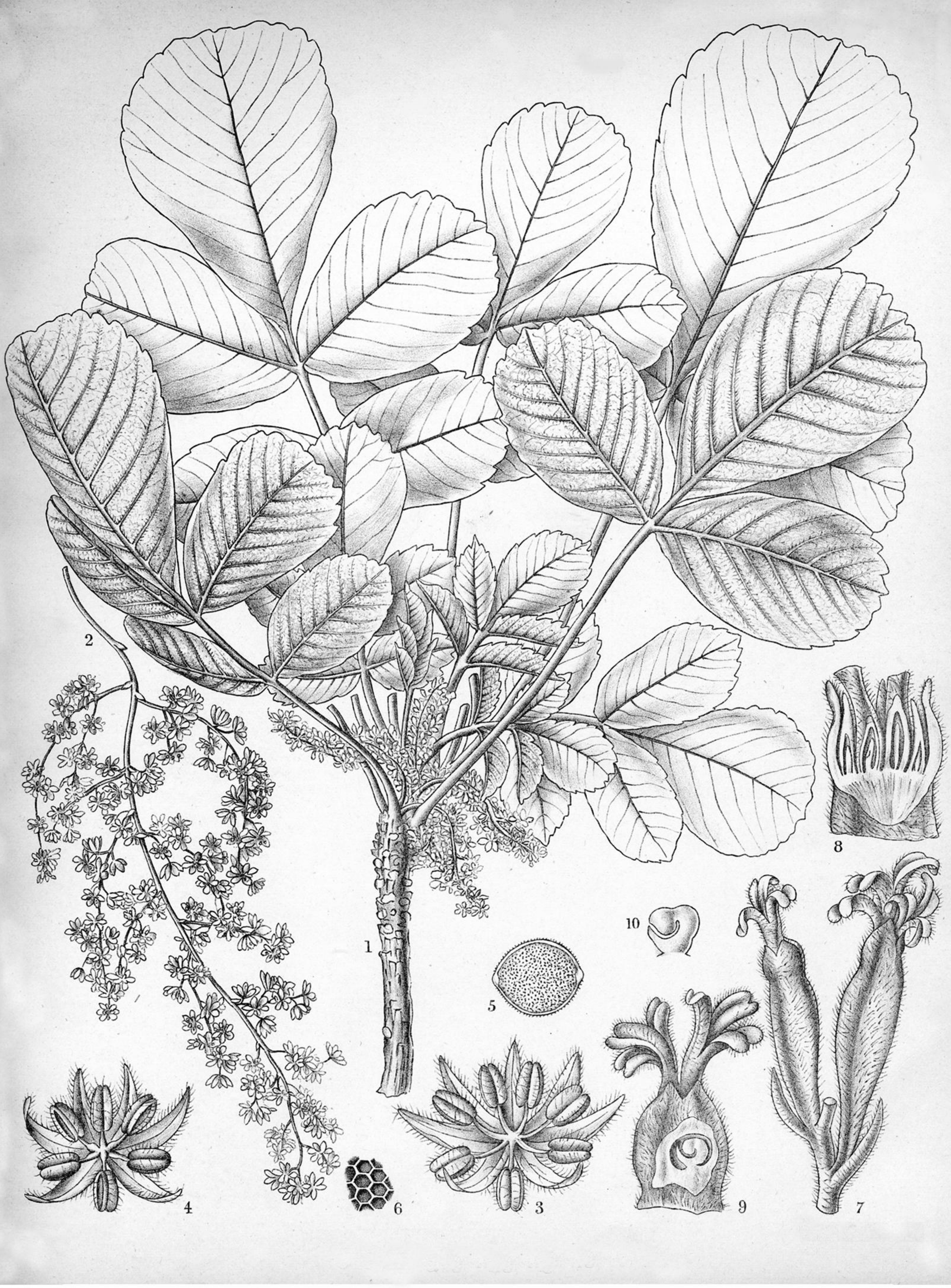


PLATE 18.

Juliania adstringens, SCHL.

Fig. 1.—A branch bearing ♂ flowers. Natural size. PRINGLE, 7243.

Fig. 2.—A ♂ inflorescence. Natural size. PRINGLE, 8533.

Fig. 3.—A heptamerous ♂ flower. About × 10. PRINGLE, 8533.

Fig. 4.—A hexamerous ♂ flower. About × 10. PRINGLE, 7243.

Fig. 5.—A pollen grain. About × 400. PRINGLE, 8533.

Fig. 6.—A portion of the surface of the same. × 1000.

Fig. 7.—A pair of ♀ inflorescences, one of which has two fully developed flowers with exserted styles, the other only one. About × 3. ROSE and HAY, 5341.

Fig. 8.—A longitudinal section of a ♀ inflorescence, showing portions of four flowers, the two lateral having imperfectly developed styles. About × 5. ROSE and HAY, 5341.

Fig. 9.—A longitudinal section through the broad plane of an ovary, showing the solitary, basal ovule. About × 4. ROSE and HAY, 5341.

Fig. 10.—The same ovule. About × 6.

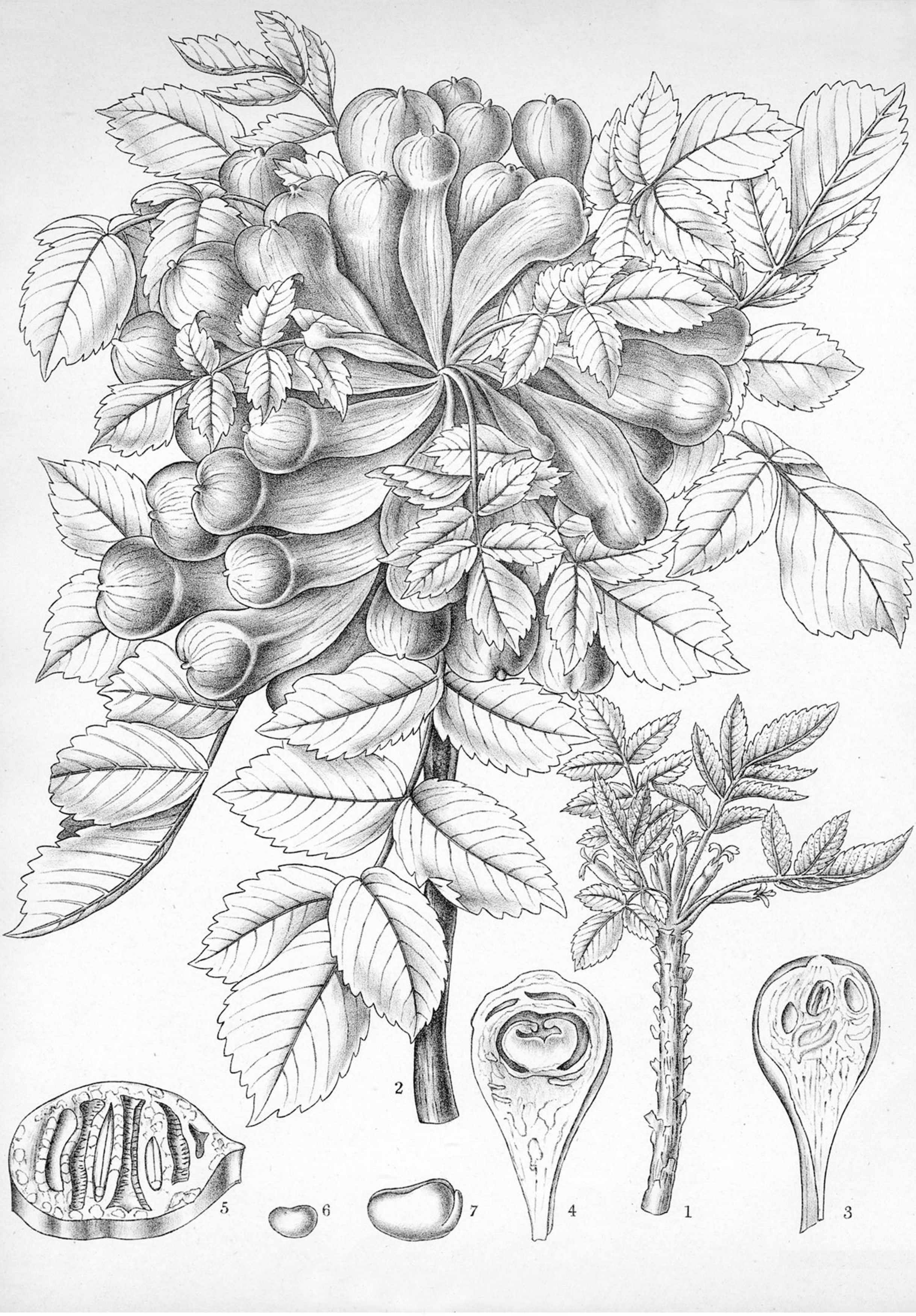


PLATE 19.

Juliania adstringens, SCHL.

Fig. 1.—A branch bearing young leaves and ♀ flowers. Natural size. ROSE and HAY, 5341.

Fig. 2.—A branch bearing ripe fruit. Natural size. ROSE and PAINTER, 6550.

Fig. 3.—A longitudinal section of an imperfect infrutescence, showing oblique position of empty carpels. About × $2\frac{1}{2}$. LANGLASSÉ, 319, *bis*.

Fig. 4.—A longitudinal section of an imperfect infrutescence of the same specimen as the last, showing a grown-out ovule without any development of embryo, probably because unfertilised.

Fig. 5.—A cross-section of a ripe fruit through the seeds of the two fertile flowers. About × 3. NELSON, 1706.

Fig. 6.—A ripe seed. Natural size. ROSE and PAINTER, 6550.

Fig. 7.—An embryo from the same specimen. About × 3.

PLATE 20.

Juliania amplifolia, HEMSLEY and ROSE.

Fig. 1.—A branch bearing half-ripe fruit. Natural size.

Fig. 2.—Upper portion of half-ripe fruit, bearing the free tips of the involucral bracts and the remains of the styles. About × 3.

Fig. 3.—Remains of a style below the free stigmatic arms. About × 5.

Fig. 4.—A section of a half-ripe carpel, showing a grown-out ovule without any obvious development of embryo. About × 2.

Fig. 5.—The same ovule, showing a groove on the outer edge of the funicular appendage.

Fig. 6.—An ovule. Natural size.

Fig. 7.—The same enlarged.

Fig. 8.—The same, showing a groove on the inner margin of the funicular appendage.

Fig. 9.—A cross-section of fig. 5 below the embryonal lobe.

Fig. 10.—An ovule, in which the funicular appendage is folded back on the embryoniferous part. About × 3.

PLATE 21.

Juliania amplifolia, HEMSLEY and ROSE.

Fig. 1.—A branch bearing ripe fruit. Natural size.

Figs. 2, 3, and 4.—Cross-sections, at different heights, of a ripe fruit, showing the seeds in the central carpels, and malformed growths in the lateral ones. About × $2\frac{1}{2}$.

Fig. 5.—A ripe seed. About × 5.

Fig. 6.—A section of a seed through its greatest diameter, showing accumbent radicle.

Fig. 7.—An embryo. Natural size.

Fig. 8.—The same. About × 6.

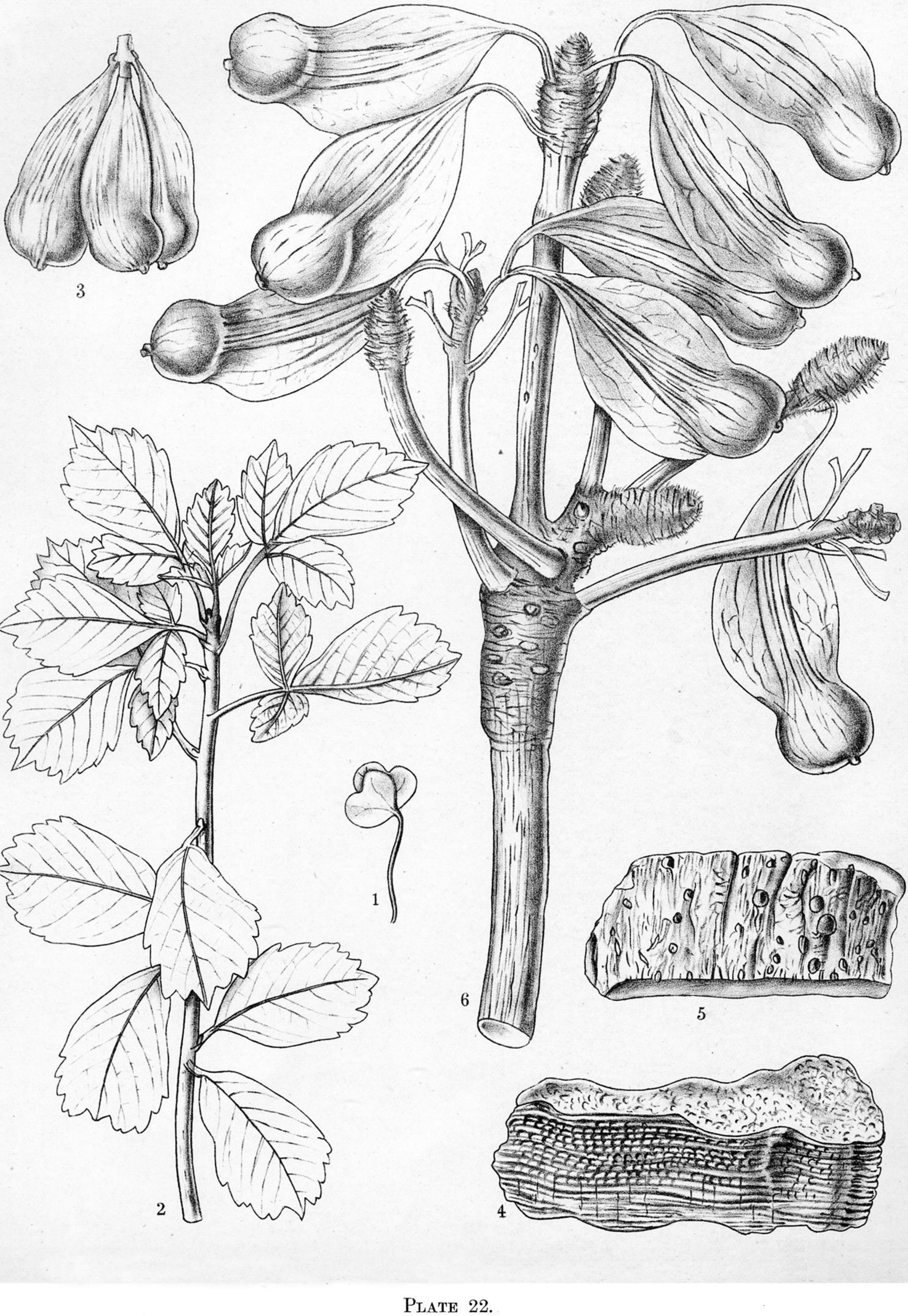


Plate 22.

Juliania adstringens, Schl.

Fig. 1.—A seedling in an early stage. Natural size. Rose and Hay, 5341.

Fig. 2.—A barren shoot bearing simple and trifoliolate leaves. Natural size. Rose and Painter, 6550.

Fig. 3.—Peduncle bearing three fruits. Rose.

Figs. 4 and 5.—Superficial and sectional views of old bark. Natural size. Rose and Painter, 6550.

Juliania amplifolia, Hemsley and Rose.

Fig. 6.—Fruiting branch after the fall of the leaf. Natural size. Rose and Painter, 7425.

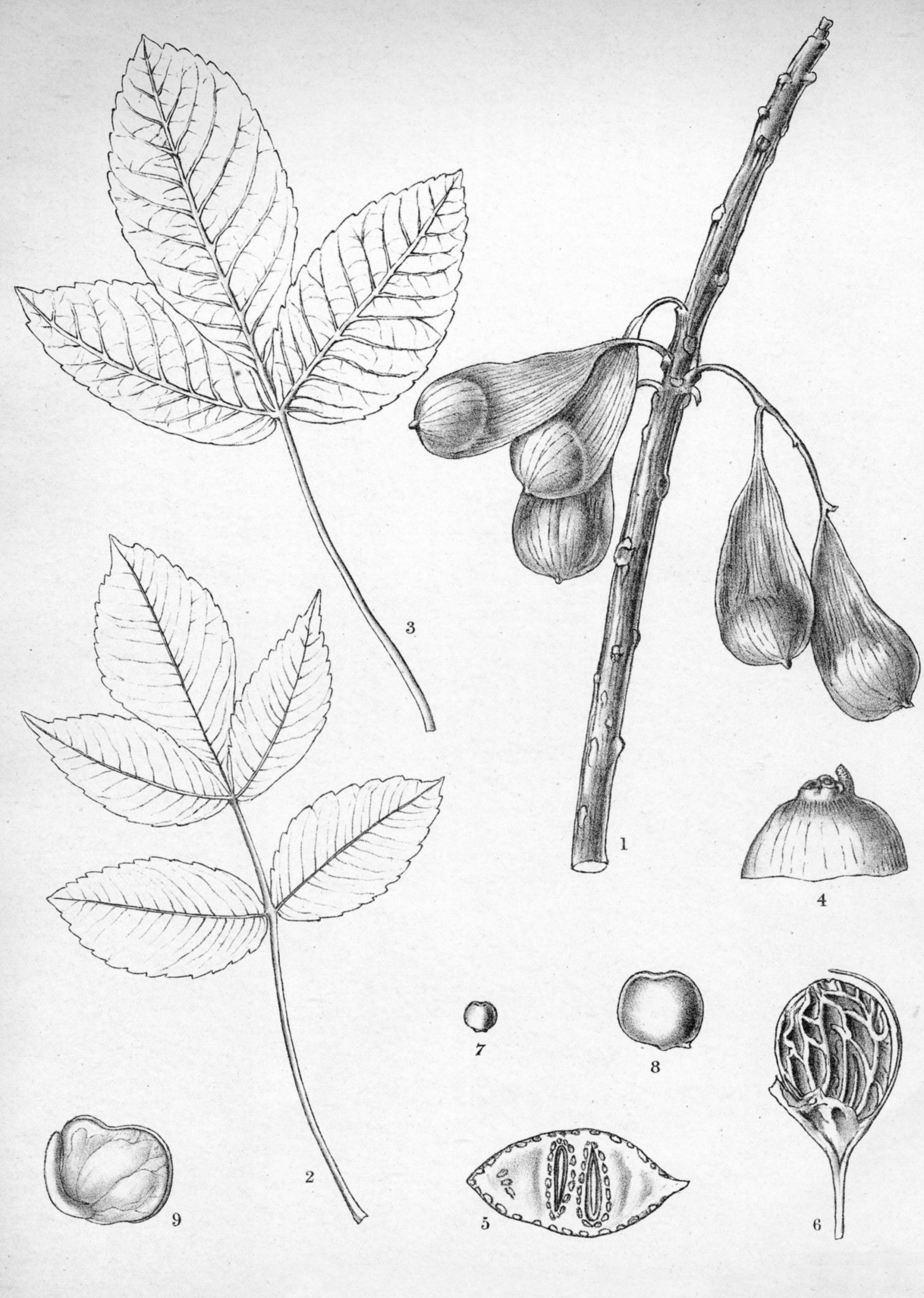


Plate 23.

Juliania glauca, Hemsley and Rose.

Fig. 1.—Branch bearing ripe fruit, after the fall of the leaf. Natural size.
Figs. 2 and 3.—Detached leaves. Natural size.
Fig. 4.—Top of fruit, enlarged one-half.
Fig. 5.—Cross-section of a fruit, showing the seed in two ovaries. No trace of lateral flowers. About × 2.
Fig. 6.—A nut denuded of its epicarp. About × 4.
Figs. 7 and 8.—A seed, natural size and enlarged about three times.
Fig. 9.—An embryo in natural position. About × 5.

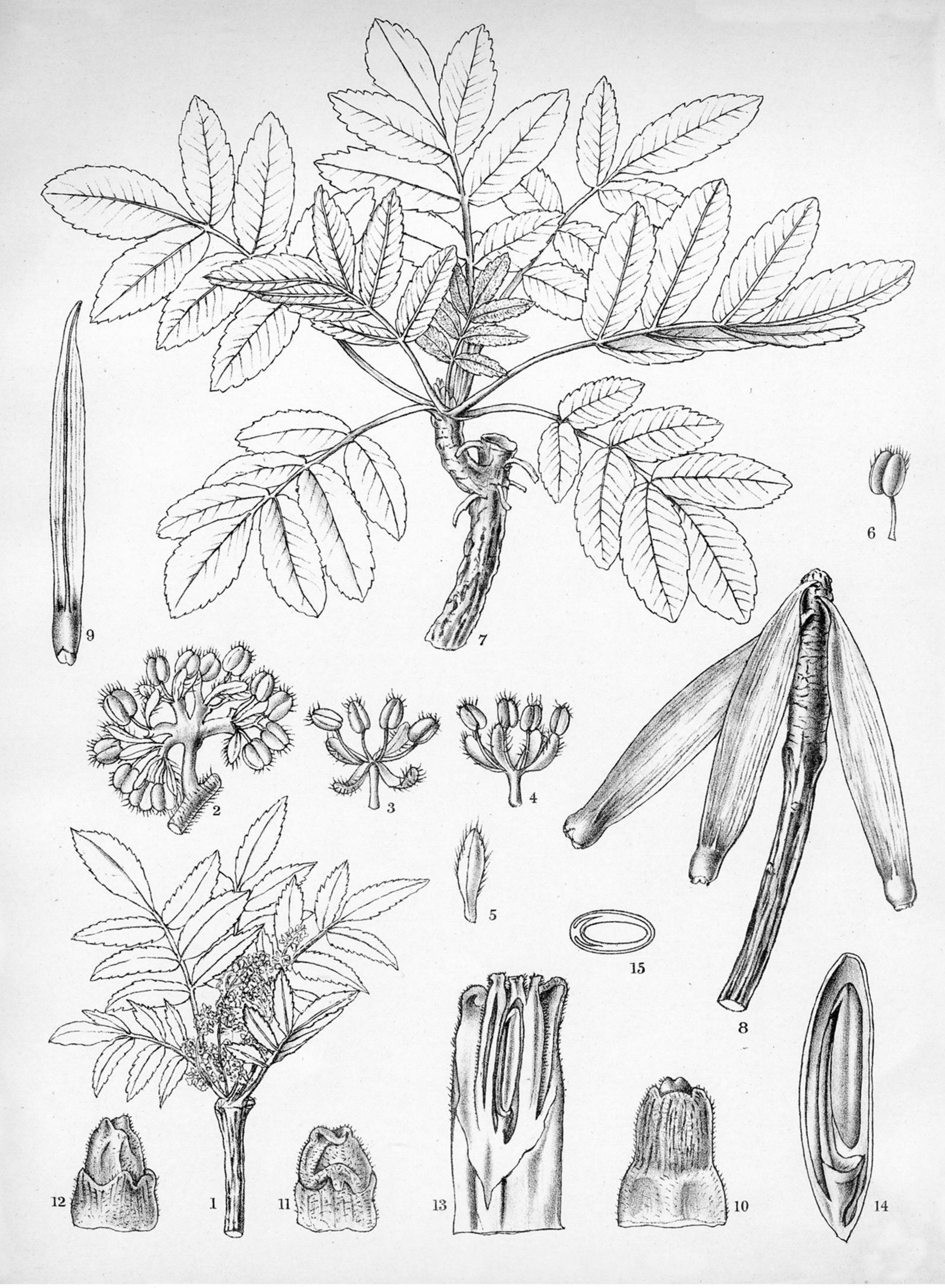


PLATE 24.

Orthopterygium Huaucui, HEMSLEY.

Fig. 1.—A branch bearing ♂ flowers. Natural size. MACLEAN.

Fig. 2.—A portion of a ♂ inflorescence from the same. About × 5.

Figs. 3 and 4.—Male flowers from the same. About × 8.

Fig. 5.—A perianth-segment from the same.

Fig. 6.—A more enlarged stamen from the same.

Fig. 7.—A branch. Natural size. MATHEWS, 591.

Fig. 8.—A branch bearing fruits, after the fall of the leaf. Natural size. MATHEWS, 591.

Fig. 9.—An imperfect fruit, from the same. Natural size.

Figs. 10, 11, and 12.—Views of the apex of imperfect fruits. About × 3.

Fig. 13.—Longitudinal section of an imperfect fruit, showing traces of three flowers, the central one fertile and the two lateral imperfect.

Fig. 14.—A longitudinal section of an ovary, showing the laterally adnate, bilamellate funicle, with a cup-like base, and the pendulous embryoniferous part of the ovule—partly diagrammatic. About × 6.

Fig. 15.—Diagrammatic cross-section of the middle of the last.